REPORT OF

Fifteenth Annual

Date Growers' Institute

HELD IN

COACHELLA VALLEY

CALIFORNIA

APRIL 9, 1938

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Fifteenth Annual Date Growers' Institute

Saturday, April 9, 1938

MORNING SESSION

Chairman, Dr. W. W. Aldrich, Senior Horticulturist in Charge of U. S. Department of Agriculture Date Gardens, Indio, California

The Size of Date Fruit As Affected By Soil Moisture

By Dewey C. Moore, U. S. Bureau of Plant Industry, Indio, California

IN 1935, at the suggestion of Dr. E. C. Auchter, a study was started at the U. S. Experiment Date Garden to obtain preliminary information upon the responses of the date to soil moisture. With only a few palms of any one variety available at the Station, only one palm was used in observing the response to each soil moisture condition. Whereas Deglet Noor is the leading commercial variety, sufficient uniform palms of this variety were not available at the U. S. Experiment Date Garden. Therefore, the Hayany variety was used, because palms of this variety were available and favorably located for this experiment. Three years' results, while not conclusive, seem to justify a progress report to the date industry at this time.

Methods

To produce different soil moisture conditions, the amount of irrigation water applied to each experimental palm in the row was varied as follows:

Palm 9=No irrigation
Palm 7= 4 acre-feet per year
Palm 5= 8 acre-feet per year
Palm 3=15 acre-feet per year
Palm 1=20 acre-feet per year

The even numbered palms, separating the experimental palms, received water at the rate of 8 acre-feet per year.

The relation of amount of water applied to the resulting increase in soil moisture is important, but this relation was not a part of the experiment. This phase of the irrigation problem is receiving careful study by Mr. A. F. Pillsbury, of the University of California, Riverside (2) (3). Undoubtedly, a considerable portion of the water applied was lost by evaporation from the free water surface during and immediately following irrigation, and from the top foot of soil between irrigations.

The important factor affecting the response of the date was probably the extent of the soil in the major root zone in which the moisture was not appreciably above the "permanent wilting percentage" for that soil. Therefore, soil moisture was determined from time to time, for each foot to a depth of six feet; and the percentage of soil moisture compared with the "permanent wilting percentage" for that depth.

The "permanent wilting percentage" is a very important characteristic of any particular soil, and deserves emphasis at this time. The "permanent wilting percentage" varies with the soil type, but does not vary appreciably with the kind of plant growing in the soil. The "permanent wilting percentage" may be thought of as that moisture content of the soil at which water movement to the roots is so slow that the plant in cool, moist air will wilt. When moisture content of any portion of the soil is reduced to the "permanent wilting percentage," date roots in that particular portion of soil will not take up an appreciable amount of water.

Results in 1935

The large standard error of average values for "permanent wilting percentage," together with fluctuations in soil moisture values for record palms, due apparently to variations in soil texture and structure between adjacent holes, makes interpretations of small differences between soil moisture and "permanent wilting percentage" unwise. However, the results are probably typical of those a date grower would obtain if he attempted fairly systematic examination of his soil with a standard soil tube.

An example of the results of comparing the moisture content of the soil with the "permanent wilting percentage" of that soil is shown by the results for the fourth and fifth feet of soil in 1935, given in Table 1.

TABLE 1

The months in 1935 when Soil Moisture in the Fourth and Fifth Feet was Found at the Permanent Wilting Percentage

Palm No.	April	May	June	July	Aug.	Sept.
			Fourth Foot of Soil			
9	XX		XX	XX	XX	XX
7	XX	XX	XX	XX	XX	XX
5	XX		XX			XX
3						
1	XX					
			Fifth Foot of Soil			
9	XX		XX	XX	XX	XX
7	XX	XX	XX		XX	XX
5	XX	XX	XX		XX	XX
3	XX					
1						

Table 1 shows that in the fourth foot the soil moisture for Palm 5 was found at the "permanent wilting percentage" in fewer of the months in which samples were taken than for Palms 7 and 9. Also, in the fourth foot the soil moisture for Palm 1 was found at the "permanent wilting percentage" less often than for Palm 5.

In the fifth foot, the soil moisture for Palm 1 was not found at the "permanent wilting percentage," whereas for Palm 3 it was found at the "permanent wilting percentage" in April.

Similar studies of soil moisture in relation to the "permanent wilting percentage" were made for all depths, for 1936 and 1937 as well as for 1935. These studies show that, in general, the soil moisture for Palm 9, was found at the "permanent wilting percentage" at more depths and oftener during each year than for the other palms, which received some direct irrigation. With the greater amount of irrigation water applied, soil samples showing the soil moisture at the "permanent wilting percentage" were found in fewer months.

To measure the response of these Hayany palms to these different soil moisture conditions, the number of leaves produced each year was counted. To correct for variations in palm size, the number of leaves produced each year is expressed as percentage of the total number of leaves on the palm at the beginning of the experiment (January, 1935). The average weight per (ripe) fruit was determined at harvest. These responses for each palm in 1935 are given in Table 2.

TABLE 2

Effect of Decreasing the Proportion of Soil with Moisture Content at the Permanent Wilting Percentage, by Increased Irrigation in 1935, Upon Increasing the Number of Leaves and Size of Fruit in 1935.

Palm No.	Amount of Irrigation Water Applied	Percentage Increase in Number of Leaves	Weight per Fruit
	(acre-feet)	(percent)	(gm.)
9	0	23	9.1
7	4	31	12.2
5	8	34	13.2
3	15	42	14.5
1	20	52	15.5

From Table 2 it is evident that with increased amounts of irrigation water, which reduced the proportion of soil with moisture content at the "permanent wilting percentage," both number of leaves and fruit size were increased.

Results in 1936

The results in 1936, given in Table 3, were essentially the same.

TABLE 3

Effect of Decreasing the Proportion of Soil with Moisture Content at the Permanent Wilting Percentage, by Increased Irrigation in 1936, Upon Number of Leaves and Size of Fruit in 1936.

Palm No.	Amount of Irrigation Water Applied	Percentage Increase in Number of Leaves	Weight per Fruit
	(acre-feet)	(percent)	(gm.)
9	0	23	9.7
7	4	17	11.7
5	8	28	13.4
3	15	36	15.7
1	20	45	17.3

These 1936 results show again that with increased amounts of irrigation water, which reduced the proportion of soil with moisture content at the "permanent wilting percentage," both number of leaves and fruit size were usually increased. The only exception was Palm 7, which showed a lower percentage increase in number of leaves than Palm 9.

Results in 1937

In 1937 the soil moisture was higher for all irrigated palms than in either 1933 or 1936. This was probably the result of better penetration of irrigation water, due to the improvement of the soil structure following gypsum applications. For Palm 9, without surface irrigation, the soil undoubtedly received considerable water by lateral movement from the soil of adjacent irrigated palms.

In 1937 no soil was found at the "permanent wilting percentage" for Palms 5, 3 and 1.

TABLE 4

Effects of Increased Irrigation in 1935, 1936 and 1937 Upon Increasing the Number of Leaves and Size of Fruit in 1937.

Palm No.	Amount of Irrigation Water Applied	Percentage Increase in Number of Leaves	Weight per Fruit
	(acre-feet)	(percent)	(gm.)
9	0	Lost	9.4
7	4	12	11.3
5	8	35	12.4
3	15	27	14.9
1	20	32	15.6

Table 4 shows that the percentage increase in number of leaves was no greater for Palms 3 and 1 than for Palm 5, whereas in 1935 and 1936 such was the case. In other words, when no soil was found with moisture content at the "permanent wilting percentage," increasing the amount of irrigation water applied did not increase the percentage of leaves developed.

However, some soil samples for Palms 9 and 7 did show soil moisture at the "permanent wilting percentage." Table 4 shows a lower percentage of leaves developed on Palm 7 than on Palms 5, 3 and 1, for which no soil was found at the "permanent wilting percentage." Thus, when increased irrigation prevented soil moisture being depleted to the "permanent wilting percentage," the increased irrigation did result in a greater number of leaves per palm.

Fruit size in 1937, however, was greater with the larger irrigation applications. The larger fruit on Palms 5, 3 and 1 than on Palms 9 and 7 was probably in part due to the fact that for Palms 5, 3 and 1 soil moisture was not reduced to the "permanent wilting percentage." However, the larger fruit on Palm 3 than on Palm 5, and the larger fruit on Palm 1 than on Palm 3, was probably largely due to some growth character in 1937, such as leaf size or fruit strand size, which could have been affected by the soil moisture conditions in 1935 and 1936.

Since Eaton (1) and others have suggested that salts injurious to plants might be carried to soil below the major root zone by adequate irrigation water, it is possible that the greater leaf and fruit growth with the increased irrigation might have been in part due to the removal of injurious salts by this increased irrigation.

Summary

Three years' of study of the response of the Hayany date to soil moisture indicate that:

(1) Irrigation water applied in amounts of 8, 15 and 20 acre-feet per year did not in 1935 and 1936 prevent some soil to a depth of 6 feet having soil moisture reduced to the "permanent wilting percentage."

(2) Where increased amounts of irrigation reduced the proportion of soil with moisture content at the "permanent wilting percentage," then the increased amounts of irrigation water usually increased both the number of leaves produced and the size of the fruit.

Literature Cited

(1) Eaton, Frank M. Significance of Salt in Coachella Valley Agriculture. Report of 14th Annual Date Growers' Institute pp. 11-12, 1937.

(2) Pillsbury, Arthur F. Report of Preliminary Irrigation Investigations in Coachella Valley, California. 1932 (mimeographed circular).

(3) Pillsbury, Arthur F. How Much Water Does a Date Palm Use? Report of 14th Annual Date Growers' Institute pp. 13-16. 1937.

A Preliminary Report On A Simple and Rapid Method for Determining the Moisture Content of Dates

By G. Leonard Rygg, Assistant Physiologist, Division of Fruit and Vegetable Crops and Diseases, Indio, California

THE moisture content of dates is of prime importance in determining whether or not they will keep at ordinary room temperatures without molding or scuring. The maximum moisture content which dates may have without being subject to deterioration from molding or scuring may vary with different varieties, but with the Deglet Noor the limit ap-

pears to be in the vicinity of 25 per cent when held at ordinary room temperatures (1).

More work needs to be done in order to learn more accurately the maximum water content which the various varieties of dates may contain before they will sour or mold at the different temperatures. This information is especially desirable in connection with handling whole dates, crushed dates, and other moist date products which are not held under refrigeration.

The moisture content of dates also affects their susceptibility to sugar spotting although there is also a varietal difference (2).

In order to determine whether or not a given lot of dates will sour or mold at ordinary room temperatures as nearly as our present knowledge permits, a quick method for determining the moisture content is desirable. For this purpose the use of the refractometer is suggested as worthy of trial. With this instrument the actual determination of the water content takes only one or two minutes after the sample has been prepared, compared to from 1 to 8 hours boiling by the toluene method. Five hours was adopted as the boiling period in the series of comparisons given in this paper.

The functioning of the refractometer is based on the fact that light passing obliquely through a solution is refracted or turned at the surface of the solution and that the refraction by a given liquid is proportional to the amount of substances in solution. The refractive index is read directly on a scale on the refractometer and the percentage of dry substances is obtained by referring to tables provided by the makers of the instrument. These tables are also available in various handbooks. From these results the percentage of water is obtained by subtracting the figure from 100. These results actually give the proportion of water to the total amount of dry substances dissolved in the water, but the proportion of insoluable solids in ripe dates is so small that the results are not materially affected.

Making moisture determinations with the refractometer is simple and rapid and can be done by anyone with a small amount of practice. It is necessary to take the usual precautions of being certain that the sample is a fair representation of the lot being tested; in addition, care must be taken to keep grit or other hard substances from coming in contact with the glass surfaces of the refractometer as the glass is soft and easily scratched. Pressing the ground sample through a 70-mesh brass wire cloth removes the coarser particles but the dates should be as clean as possible before beginning the determination. The temperature must also be controlled while the reading is being made, as the refractive index changes with changing temperatures, although a variation of 10 degrees Fahrenheit makes a difference of only about one-half per cent in the determination.

This method has been tried on six varieties of dates with moisture contents ranging from 17 to 38 per cent and compared with results obtained by the toluene method. The average difference between the two methods in 36 determinations by each method was one-half of one per cent. The results obtained by the toluene method were slightly higher in the majority of instances, but in no instance was the difference greater than about one per cent. A summary of the results of these determinations is given in the accompanying table.

Comparison of Water Contents of Dates as Determined by Refractometer and Toluene Methods

Variety	Water Content: Refractometer Method Per Cent	Water Content: Toluene Method Per Cent	Difference Per Cent
Thoory	16.9	17.7	.8
Deglet Noor	23.4	23.5	.1
Saidy	26.2	26.6	.4
Halawy	27.9	28.8	.9
Barhee	33.5	33.7	.2
Black Seedling	35.6	36.5	.9

References

(1) Barger, W. R. Experiments in hydrating dry Deglet Noor Dates. Date Growers' Inst. Ann. Rept. 13: 14-16. 1936.

(2) Barger, W. R. Experiments with California dates in storage. Date Growers' Inst. Ann. Rept. 10: 3-5, 1933.

Observations On So-Called Decline Disease

By R. H. Postlethwaite, M. I. E. E.

(Read by Kenneth Peck)

THIS disease was probably first noticed in 1921 but little was done about it until 1929 when the writer experimented with an application of 50 pounds of copper sulphate in a palm basin (see Hilgardia, April, 1931, by Haas and Klotz). The palm treated at that time had practically lost all its roots and was rapidly going back. Photographs showing this palm and the adjoining control palm taken two years after treatment are published in the same issue of Hilgardia and plainly show the very marked improvement in the treated palm. This treated palm although unfertilized during the succeeding seven years is still growing and bearing merchantable fruit.

It is also shown by the same authorities that the soil surrounding the decline diseased palms was lower in potassium and higher in calcium than the soil surrounding healthy palms. Soil analyses made by Dr. F. L. Hibbard of Berkeley also showed that the available phosphate was much lower in spite of the fact that in previous years both areas had received the same fertilization, evidently a zeolitic condition existed in some areas possibly due to the excess of calcium.

Analyses show that the pinnaae of the diseased palms are also lower in nitrogen, potassium and phosphorus than those taken from healthy palms.

Referring to Bulletin 522 by Drs. Fawcett and Klotz, this corroborates the analyses in Hilgardia, the following remarks on pages 12 and 13 are interesting: "Many of the roots of these affected palms are found to have deteriorated and died, and brown patches may be found on those still alive, some of these same patches are also commonly found on sound roots of healthy trees. As high as 90% of the roots may be dead on some palms that are badly affected with decline."

Certain palms affected with decline disease, as well as offshoots from such palms, have been removed from diseased areas to other areas in the same garden, after a time these transplanted palms have recovered and become healthy normal trees, this observation suggests relation to a soil condition.

The two papers by Drs. Haas and Klotz in the 1930 issue of the Date Growers' Institute meeting and the one by Dr. Klotz in the 1931 issue are well worth reading again as they all refer to the decline disease.

In the 1933 issue of the Institute transactions Dr. Bliss read a paper in which a very wise remark occurs: "In characterizing this malady it is not yet possible to distinguish with certainty between cause and effect." This statement will be referred to later in this paper.

In the 1934 issue Dr. Bliss read a paper in which the following appears: "Deglet Noor is peculiar because of its susceptibility, no cases of decline have yet been reported in the Zahidi, Khustawy, Halawi, Tazizaoot and Iteema varieties although trees of these varieties are known to be growing in close proximity to the disease."

The paper then recites that the various chemical treatments including copper sulphate have shown little or no visible results, and no definite clues have developed from these experiments as to the cause of the decline disease. Further experiments in inoculated potted seedlings showed that the fungus species Omphalia is the only organism which has proved to be strongly pathogenic on the underground portions of seedling date palms.

In the 1935 issue Dr. Bliss read a paper in which he apparently takes the definite position that Omphalia fungus is the cause of Decline Disease, the argument being largely based on the result of experiments on seedlings grown in pots and inoculated with the fungus.

In the 1937 issue Dr. Bliss read a paper stating, "There is evidence that decline disease of date palms is caused by a soil-inhabiting fungus which belongs to the genus Omphalia."

In the 1937 issue Dr. Bliss apparently takes the position that Omphalia is the cause of decline disease and suggests the only certain remedy is to dig out the diseased palms, disinfect the ground and plant new offshoots.

As the writer has now no financial interest in date gardens and in spite of the fact that it may appear presumptious in an old date grower to question the correctness of the diagnosis of an eminent plant pathologist, the following remarks may be in order.

In the first place there is proof that proper application of copper sulphate has resulted in at least one diseased palm growing new roots and again bearing commercial fruit even without proper fertilization.

Secondly, it is sometimes very difficult to differentiate between cause and effect, as pointed out by Dr. Bliss but it seems to have been taken for granted that because Omphalia is found on the roots of diseased palms and the roots are dead, therefore Omphalia is the cause of the disease.

It is stated that only Deglet Noor palms are affected, but as far as I know, no study has been made to determine if the root structure of Deglet palms is essentially different from the root structure of other varieties which are not killed by Omphalia. If all date palm roots are similar in composition and structure, which may be assumed unless proved otherwise, then Omphalia may not be the primary cause of decline disease but may be of a secondary nature. The primary cause under such conditions might still be a local nutritional deficiency affecting the metabolism of the particular palm.

Dr. P. L. Hibbard reports that prune trees in a certain locality where the available phosphate was low showed a lack of vitality, the addition of large amounts of phosphate had no effect but the application of five pounds of copper sulphate per tree made a big improvement, in a similar case with peach trees a great improvement was made by the application of fifteen pounds of ferrous sulphate.

If the cause of decline disease originates in the faulty metabolism of the palm it will gradually weaken the root system and encourage the attack of Omphalia and other fungi.

It appears that under natural field conditions the symptoms of decline do not generally take place until the palm is several years old, thus the probability is further strengthened that the true primary cause of decline disease may be inherent in the tree itself or possibly due to some nutritional deficiency and not to the attack of any outside agency.

The reason for this paper is to induce both date growers and the scientists of the Citrus Experiment Station to further investigate the cause of decline disease before applying the problematical remedy suggested by Dr. Bliss, namely to take out the palms, sterilize the ground and replant, which is so drastic that more thought and study seems indicated.

To remove an acre of palms over six to eight years old which has already cost some $3,000.00; to sterilize, replant and to care for the replants another six years means a total cost of at least $5,000.00.

However carefully soil sterilization is done, perfection is seldom attained and if some Omphalia fungus was left alive, the final result would, if Omphalia was really the primary cause of decline, be the loss of the second planting. This is too serious a matter for the Deglet Noor industry to lightly contemplate.

Discussion

Mr. Peck: Dr. Bliss, have you made any further study of that point which Mr. Postlethwaite brings up in this paper? Have you any idea why Deglet Noor is the only variety affected with the decline disease?

Dr. Bliss: Recent studies indicate that the Deglet Noor variety is not the only one affected with decline disease. In August, 1935, a group of 65 toadstools of Omphalia sp. was found arising from the base of a young Saidy date palm at the Citrus Experiment Station, Riverside, California. (See Mycologia 30 (3) 1938.) In December, 1937, near Coachella, California, the typical root rot of decline disease was found in two male palms situated near a group of affected Deglet Noor palms. Omphalia sp. was isolated from lesions in 13 out of 15 roots selected from the two male palms. Omphalia sp. was isolated also to a limited extent from both living and dead roots of an Iteema palm near Oasis, California. This palm, which stood at the edge of a decline disease area, was not noticeably affected in outward appearance by the disease. Cultures of Omphalia spp. were obtained also from dead roots of palms of the Tafazwin, Zahidi, and Horra varieties.

Experimental and observational evidence (see Date Growers' Instit. Ann. Reports 11, 12, and 14) has been presented which points to the conclusion that decline disease is caused by two species of the genus Omphalia. Root decay, initiated by one or

both of these species, constitutes the primary symptom upon which I base the critical diagnosis of decline disease. The more obvious characteristics of affected palms, such as retardation in growth, poor quality of fruit, etc., are now considered secondary symptoms because they merely reflect the bad condition of the roots. Because of the rather indefinite nature of these secondary symptoms, one is apt to confuse the decline disease (Omphalia root rot) with other maladies which are due to entirely different causes.

No one has discovered the reason why the roots of the Deglet Noor variety are more susceptible to the attack of Omphalia spp. than are the roots of certain other varieties. Many similar instances are known in which varieties of the same species of plants vary widely in their relative susceptibility to the same fungus. Omphalia spp. have attacked, under experimental conditions, the living, unwounded tissues of the Deglet Noor variety and a large number of seedling date palms. It is probable that the two male palms and the Iteema palm (mentioned above) were attacked in a similar manner. All of these cases show more or less susceptibility to the decline disease. Where Omphalia spp. were isolated only from the dead roots of certain varieties, there is no proof that such varieties are injured by the disease.

Since palms of the Kustawy, Zahidi, Tafazwin, Deglet Beida, and Halawy varieties have grown for years in close proximity to the decline disease without becoming seriously affected, there is circumstantial evidence that there are differences in varietal susceptibility to decline disease and that disease-resistant varieties may be found which can be substituted for Deglet Noor in diseased areas where soil disinfection is not practicable.

Dr. Fawcett: Mr. Postlethwaite has expressed the hope in his paper that this investigation will be continued. He also states that he is not in agreement with Dr. Bliss' conclusions as to the cause of the decline disease on date palms.

I wish to say that Mr. Postlethwaite was one of our good cooperators in carrying on the investigations while he was in Coachella Valley, and we fully respect his viewpint regarding this disease. This investigation is being actively continued by Dr. Bliss. He has a number of experiments going, to find out further facts regarding the disease.

A planting of 18 varieties of date palms has been developed in an isolated place for the purpose of making further inoculations with the Omphalia fungus in order to test the relative resistance of various varieties.

I may point out that when the decline disease was first drawn to the attention of the Citrus Experiment Station there was only one area known and this was in the Gillette-Rosenberger orchard. At that time and for several years afterwards there was a general opinion by many people that it might be a nutritional disease, and a number of fertilizers and other materials were used on this area without any effect. As a result of Dr. Bliss' investigations it has been found that the Omphalia fungus is constantly associated with the disease and that it can be reproduced on healthy palms by inoculation with this fungus. Many of the results of Dr. Bliss' investigations have been already published in previous reports of these proceedings. There are other more recent results with which apparently Mr. Postlethwaite was not fully acquainted.

The interplanting of grapefruit in the Gillette-Rosenberger orchard was made by Dr. Webber and myself with the idea that it might throw some light on the cause of the date decline disease if it were nutritional, since the nutrition of citrus was better known than that of dates.

The trees were planted so that they would extend through the diseased area and through the part of the orchard that was still healthy. Another planting was made in the Middleton orchard in another part of the valley. It was found later that the citrus trees grew fully as well in the area where the date palms were diseased, as they did where they were healthy. This might be considered an added reason, along with Dr. Bliss' other data, that the disease is not necessarily a nutritional one.

Spoilage of Dates As Related To Management of the Fruit Bunch *

By Donald E. Bliss, Assistant Plant Pathologist, Citrus Experiment Station, Riverside, California

Introduction

THE term "spoilage" may be defined as the loss of valuable qualities, or becoming tainted, decayed, or wasted. When applied to dates, "spoilage" may refer to any condition in which the desirable qualities of the fruit are impaired or destroyed. Many common ailments may be included in the different types of fruit spoilage. Among these ailments are both physiological disturbances and pathogenic diseases. The first class includes water injury (checking and tearing), blacknose, sunburn, shrivelling, and mechanical injury; the second, rots due to microorganisms, and injuries inflicted by insects, birds, and mice.

The general subject of date fruit spoilage is therefore very broad since it is composed of many contributing factors. After considering the intricacy of this subject, one would not expect to eliminate all forms of spoilage by means of any single type of control measure. It is somewhat doubtful whether fruit spoilage can ever be prevented entirely. While attempting to achieve that purpose, one should consider different means of reducing spoilage and adopt such practices whenever practicable.

Review of Literature

From the commercial standpoint, fruit spoilage constitutes the most important group of date diseases in California. Mention has been made

*Paper No. 376, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

frequently before the Date Growers' Institute that rain and periods of high relative humidity cause severe injury to dates. H. W. Postlethwaite (15) estimates that in the Coachella Valley in 1925 losses from rain damage amounted to 20 per cent of the crop in some places and as high as 80 per cent in others. Cudebec (6) estimates that in 1926, 50 per cent of the fruit was lost on bunches of Deglet Noor variety which were not protected from rain. Nixon (11), who related checking and blacknose to water injury, states that the reduction in market value of fruit thus affected is sometimes considerable.

No reliable figures are available on the total loss from fruit spoilage. In general it may be said that different varieties of dates vary considerably in their relative susceptibility to rain damage (12) and to other types of spoilage. Immature dates are more susceptible to injury in certain stages of development than in others (8). Weather conditions are the principal contributing factors to fruit spoilage. Whereas a total loss might be incurred under very unfavorable conditions, losses in the Coachella Valley during the last five years are estimated to lie between 10 and 40 per cent.

The aeration of dates by means of a metal ring inserted in the middle of the fruit bunch was described in 1931 by Leonhardt Swingle (16). He noticed that blacknose was much more prevalent in the center of the cluster than on the outside where the fruit was more exposed to the air. Rings of copper wire, 16 inches in circumference, were inserted in midsummer to prevent closing of the hole left in the center of the bunch by the removal of the inner fruit strands. Although blacknose was not controlled entirely, Swingle believed that the method was helpful. Haas and Bliss (8) reported in 1935 certain field experiments on the aeration of fruit bunches in relation to water injury. A marked decrease in the percentage of checked fruit followed the separation of fruit strands on July 6. Conversely, the percentage of checking was increased by reducing the amount of aeration by bagging fruit bunches between July 26 and August 17. Other data were presented to indicate that bagging of the fruit bunches in the final stages of ripening was effective in reducing the percentage of torn fruits after rain. In most cases the damage was less where the skirts of the protectors (bags) were tucked up than where the skirts were down. This result was taken to indicate that, in this instance, the rain fell vertically and that after the rain the drying was increased by better aeration. In light of the experiments reported, Haas and Bliss (8) concluded that "the practice of bagging fruit bunches with paper tubes is highly desirable and serves as a protection against rain and birds. However, it is attended with the disadvantage that the covers tend to retain the transpiration water and hinder aeration, thus accentuating water injury. An ideal bag would be one which would protect the fruits from rain and birds and at the same time allow a maximum aeration. However, it should not be installed until necessary as a protection." It was noted that certain steps toward increasing the aeration of fruit bunches were already in use among the date growers. These included the removal of center fruit strands, the insertion of wire rings, better types of material for making bags, improved methods for hanging the bags, and the lifting of low-hanging bunches away from the soil.

The development of the practice of thinning fruit bunches is summarized by Nixon and Crawford (14). These authors report the results of extensive field experiments on fruit thinning in the Coachella Valley for the years 1934 and 1935. Among the results obtained, the following deal with the effect of thinning on fruit spoilage in the Deglet Noor variety: (1) Without thinning, a large percentage of the fruit shrivelled prematurely and many dates showed a tendency to mature imperfectly; (2) "checking and blacknose were increased in proportion to the amount of thinning . . . ;" and (3) "best results were secured from a total reduction at time of pollination of approximately 50 to 60 per cent in the number of dates per bunch."

In 1920 Brown (1) described the rot of date fruit and attributed the injury primarily to Alternaria. The attack of this fungus was accompanied usually by species of Aspergillus and Penicillium. In later reports, Brown (2, 4) and Fawcett and Klotz (7) mentioned fungi and bacteria of several other genera as associated with date fruit rots. During the season of 1921, and in other years thereafter, the control of date fruit rots by means of fungicides (3. 4, 5) was attempted at the Tempe date orchard in Arizona. These experiments, by J. G. Brown, included the use of bordeaux mixture, lime sulfur, and copper acetate sprays applied to the foliage and trunk during the spring and early summer months. Difficulties encountered in removing the spray residue prevented the application of these sprays to the fruit. The latest report of this work from the Arizona Agricultural Experiment Station (4) states that, ". . . although loss of fruit has been less in the orchard since the spraying program was inaugurated, fruit rot has not been prevented." In October, 1936, more than ten thousand fruits on sprayed and unsprayed palms were inspected for rot by J. G. Brown at the Tempe, Arizona, Date Garden. Of the five varieties of dates examined, three varieties "showed somewhat more fruit rot on sprayed than on unsprayed palms. . . ."

Klotz (10) found that the incidence of blacknose could be increased in bunches that were bagged by exposing the fruit to vapors of carbon bisulfide or carbon tetrachloride. Spraying and dusting with copper and sulfur fungicides had practically no effect on the occurrence of blacknose. Fawcett and Klotz (7) found no indication that blacknose is due to microorganisms, but they suggest that it is of physiological or nutritional origin.

In a recent paper, Hilgeman and Smith (9) correlate the crude fat content of date skins with water injury. A comparison of seven varieties indicates that the varieties with little crude fat are more subject to spoilage than those with much. Their work also shows that the artificial application of various undiluted oils and waxes to unripe fruit reduces loss from splitting but in many cases results in burning. Heavy additions of oils and waxes may prevent normal maturation while smaller amounts, that allow normal ripening of the fruit, fail to control moisture damage.

Experimental Work

Field experiments were devised to test the effect of aeration and thinning of the fruit bunch on the spoilage of dates. These experiments were conducted during the years 1935, 1936, and 1937, in the garden of B. S. Boyer, near Indio. The types of spoilage which were studied included checking, blacknose, and rot.

In April of each year 20 large, uniform fruit bunches were selected for use from a group of seven to ten Deglet Noor palms which were situated in the midst of a five-acre block. These palms were planted as offshoots in 1925 and 1926 and they were in a comparatively vigorous

condition. The height of the mature fruit bunches was such that in 1935 the dates were picked while standing on the ground, but in 1937 the fruit was harvested with the aid of a ten-foot ladder.

Management of the experimental fruit bunches was similar in most respects to that employed in the case of other fruit clusters on the same palms and, in general, for fruit of the Deglet Noor variety. The thinning operation was begun at the time of pollination when all of the fruit strands were shortened.

As indicated in Table 1, the final reduction in the number of fruits was made during May or early June by removing entirely a number of fruit strands from the center of the bunch. From 35 to 40 fruits were left per strand and the desired total number of fruits per bunch was obtained by adjusting the number of fruit strands.

Wire rings (Fig. 1, A) were inserted in some of the bunches shortly before the time when the green fruits obtained full size and before any water injury or blacknose had appeared. The rings were made of heavy (No. 8 gauge), galvanized iron wire, cut in lengths of 57 inches and shaped into flat nine-pointed stars with the ends of the wire overlapped and soldered together. When inserted from below in the center of a fruit bunch, one of these rings produced a circular opening of about eight inches diameter.

All of the experimental bunches were protected by heavy crepe paper tubes (commonly known as "bags" and sold under such trade names as Ripplecraft, Elasticraft, and Arksafe), which were tied at one end about the fruitstalks. These tubes, which measured 40 inches long and 36 inches wide, were installed when the dates were in the khalal stage, two to four weeks prior to the beginning of fruit harvest. Four types of bags were used. The regular type (Fig. 1, C) permitted no ventilation at the top because the entire upper edge of the tube was gathered about the fruitstalk. The aerated type of bag used in 1935 (Fig. 1, D) consisted of a long, perforated tube with a double cape; that for 1936 (Fig. 1, E) was a long, perforated tube with a single cape; while the bag used in 1937 (Fig. 1, F) was like the regular type except that one half of the upper edge of the tube was folded over and left hanging free at one side of the fruitstalk.

Wire baskets (Fig. 1, B) were hung beneath the experimental fruit bunches at the time of bagging. These 30-inch-square baskets were made of hardware cloth and were suspended from overhanging leaves. They were used to catch all fruits which dropped.

TABLE 1
Time of Different Operations in the Management of the Fruit Bunches

Operation	1935	1936	1937
Thinning completed	May	May 8	June 3
Rings inserted	July 17	July 10	July 14
Bags installed	August 27	August 19	September 1
Baskets hung	September 4	August 19	September 1
Fruit harvested	September 19 to November 22	September 1 to October 27	September 27 to November 30

The tree-ripened dates were picked and taken to the laboratory at weekly intervals. After being weighed, the fruits were examined individually and were classified according to the types of spoilage shown. The sorting was done with the aid of strong illumination so that the slightest visible evidence of injury could be detected. Fruits with small, transverse ruptures in the epidermis were said to be "checked." Those showing evidence of attack by fungi or bacteria were classified as "rotted." "Blacknose" was defined as that condition of checked fruits in which the tip end was perceptibly darkened. Each lot of fruit was rated also on appearance, quality, and freedom from blemish as suggested by Haas and Bliss (8). Judgment regarding the symptoms of fruit rot was based on numerous isolations.**

**A list of the fungi isolated together with notes on the physiology and relative importance of different date fruit rot organisms will be published at a later time.

In Table 2 is given the amount of rainfall recorded at the United States Experiment Date Garden, Indio, California, from June 1 to October 31 in the years 1935, 1936, and 1937. These records are thought to be applicable to the experiments herein reported because the rain gauge is situated within 200 yards of the experimental palms. Of the three periods mentioned, that in 1935 received 0.48 inches of rain; that in 1936 received 3.56 inches; while the period in 1937 had only 0.01 inch. In spite of the comparative wetness of 1936, the experimental fruit obtained during that year was less affected by fruit rot than that of 1935. This may be due to differences in the time of the rainstorms as related to fruit maturity. Also, the presence of a summer cover-crop contributed to the loss from fruit rot in 1935.

There were a number of days of high relative humidity during the first half of August, 1935, and fungi developed on fruits which were torn by the rain of August 14. By August 27 there was an estimated loss of 3 per cent throughout the block in which the experiment was situated. Checking was relatively severe and

TABLE 2
Rainfall recorded at the U. S. Experiment Date Garden Indio, California, during the months of June to October, inclusive, in the years 1935, 1936, and 1937*

	1935		1936		1937	
Month	Day	Rainfall, inches	Day	Rainfall, inches	Day	Rainfall, inches
June	4	trace	—	none	28	trace
July	14	trace	7	trace	5	trace
	15	trace	19	0.17	23	trace
			26	1.70		
August	14	0.36	8	0.30	5	0.01
	22	0.11	—	—	—	—
	24	trace	—	—	—	—
September	20	trace	—	none	—	none
October	1	0.01	16	1.13	—	none
	—	—	17	0.03	—	—
	—	—	18	0.22	—	—
	—	—	20	0.01	—	—

*Data supplied through the courtesy of Dewey C. Moore, Scientific Aide (date investigations), U. S. Department of Agriculture.

blacknose had appeared on some fruits.

In 1936 the pollination of the first blooms was not satisfactory and "June drop" was rather severe. Fruit development was about three weeks earlier than usual, so that much of the fruit was harvested prior to the rainstorm of October 16 to 20, inclusive. Checking was first observed on July 10 and blacknose on July 31. Also, there were some torn fruits at this time. By August 19 there were a few ripe fruits. The quality of the first picking of fruit on September 1 was unusually poor because of water injury, blacknose, and rot.

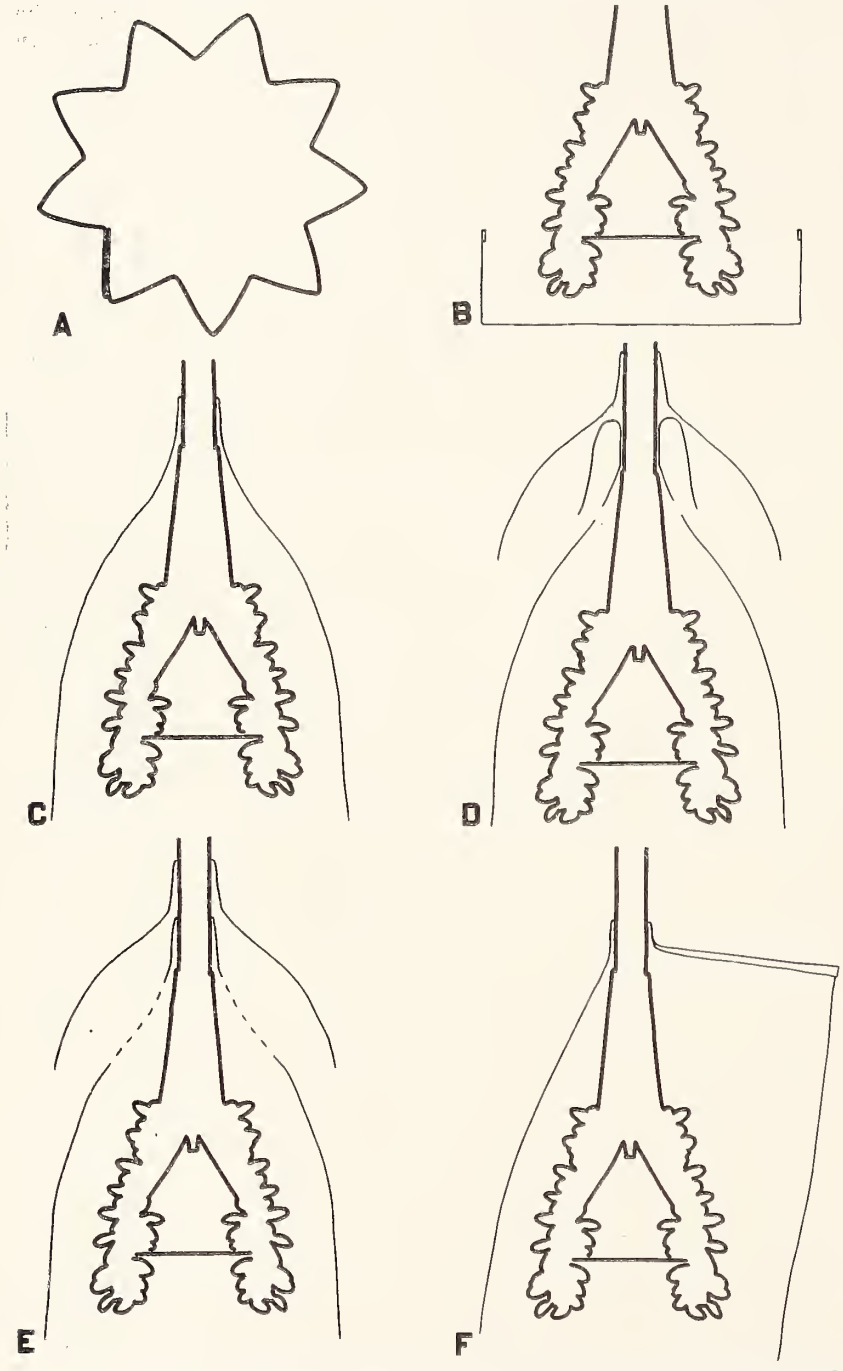


Fig. 1.—A, star-shaped wire ring used to separate the fruit strands. B-F, diagrammatic, longitudinal sections through bunches of Deglet Noor dates showing fruit strand separation by means of wire rings. B, unbagged fruit bunch with wire basket below. C, regular type of bag in which all of the upper edge of the tube is gathered about the stalk. D, aerated type of bag used in 1935. The long tube contains 30 holes of three-fourths inch diameter. E, aerated type of bag used in 1936. There are 320 holes of one-half inch diameter in an eleven-inch zone beginning eight inches below the upper edge of the long tube. F, aerated type of bag used in 1937. It is not perforated but one-half of the upper edge is folded over and left hanging free at one side of the fruitstalk. The capes in D and E consist of an unperforated paper tube cut in half. All tubes and capes are gathered and tied about the stalk so as to prevent water from reaching the fruit.

The fruit crop of 1937 was considerably affected by the very low temperatures which prevailed in January of that year (13). A reduction in the usual number of functional leaves was attended in many gardens by fruit of smaller size and inferior quality. Practically no rain fell during the fruit ripening season and there was very little damage from water injury, blacknose, and rot. This season was so dry that additional aeration of the fruit bunches was not necessary; in fact, it was perhaps detrimental to the fruit because desiccation proceeded too rapidly.

The experiments for the three years are summarized in Table 3. The 59 experimental fruit bunches are placed in 12 groups, according to the year and to the treatment received. Three kinds of bunch treatment are shown: namely, degree of thinning, type of bag, and fruit strand separation. Bunches with an estimated total number of 2,500 fruits were thinned to the extent of about 53 per cent in 1935; to about 43 and 72 per cent, respectively, for light and heavy thinning in 1936; and to about 46 and 69 per cent, respectively, for light and heavy thinning in 1937. In the experiment of 1935, where thinning was reasonably uniform, regular and aerated types of bags were used in all combinations with rings and without rings. In 1936 the aerated type of bag was used only in combination with the ring and the regular type of bag covered bunches without rings. This experiment was designed to show the effect of aeration on lightly and heavily thinned bunches. The experment of 1937 was similar to that of 1936 except that the bags were of uniform type throughout.

It will be seen that, in general, the average weight per fruit varied inversely with the number of fruits per bunch. Light thinning resulted in smaller fruits than did heavy thinning. In 1935 the incidence of checking was reduced considerably by aeration. Where aeration was employed even greater reduction was found in the percentage of rotten fruits. These trends were also reflected in the rating of the different lots; that is, fruit bunches with rings yielded better dates than those in which the fruit strands were not separated. It is of interest to note

that the management of fruit bunches in Group No. 1 was similar to that which was employed in other parts of the date garden where these experiments were conducted.

TABLE 3

Effect of bunch management on weight, spoilage, and rating of Deglet Noor dates

Group No.	No. of bunches	Bunch treatment: Average number fruits	Bunch treatment: Type bag	Bunch treatment: Strand separation	Weight per fruit, grams	Fruit spoilage, per cent: Checks	Fruit spoilage, per cent: Blacknose	Fruit spoilage, per cent: Rot	Rating: 10=perfect
				1935					
1	5	1,225	Reg.	None	9.8	62	--*	33	4.1
2	5	1,288	Aer.	None	10.0	52	--	30	4.8
3	5	1,076	Reg.	Ring	10.4	54	--	20	5.6
4	5	1,147	Aer.	Ring	10.0	43	--	24	5.7
				1936					
5	5	1,448	Reg.	None	8.9	84	11	21	5.3
6	4	1,398	Aer.	Ring	9.2	93	15	17	5.5
7	5	666	Reg.	None	10.3	91	21	10	6.8
8	5	725	Aer.	Ring	10.7	91	15	9	6.9
				1937					
9	5	1,362	Aer.	None	8.4	49	1	5	6.1
10	5	1,283	Aer.	Ring	8.6	47	1	5	6.5
11	5	745	Aer.	None	9.6	49	1	7	7.0
12	5	808	Aer.	Ring	9.8	43	1	5	7.5

*Dashes indicate no reading taken.

Checking and blacknose were severe on all lots of experimental fruit in 1936. The least damage from these types of spoilage was found in Group No. 5 where the average number of fruits per bunch was highest. The largest percentage of blacknose occurred in Group No. 7 where fruit thinning had been most severe. The incidence of rot, however, was about twice as great in the lightly thinned bunches (Groups No. 5 and 6) as in the ones with heavy thinning. Fruit quality was best in heavily thinned bunches where aeration was employed.

Although nearly one half of the fruits in the 1937 experiment were checked, the actual loss was considered very small. Blacknose was practically absent, and fruit rot was of minor importance. The different kinds of bunch management used did not affect very greatly the percentages of fruits with checks, blacknose, and rot. However, the bunches in Group No. 12 were judged to have the highest quality of fruit.

Discussion

Probably the most important indication obtained from the experiments herein reported is the effect of aeration on fruit rot. Aeration was obtained in three ways: (1) by fruit strand separation; (2) by bags which allowed increased ventilation of the fruit; and (3) by the removal of fruit strands from the center of the bunch. During the moderately wet years, such as 1935 and 1936, all of these methods were effective in reducing the percentage of rot and, when used in combination, they were of more benefit than when they were used singly. In 1937, when there was no rainfall during the ripening season, fruit rot was not decreased by additional aeration.

When reduced to simple terms, the types of bunch management which produced the best fruit brought about the following conditions: (1) the fruits were well nourished; and (2) they were ripened in a relatively dry atmosphere. It is probable that bunches of Deglet Noor dates do not require such drastic reduction as was done in the case of the heavily thinned bunches in these experiments. Probably heavier yields of somewhat smaller fruits are desirable, especially when the incidence of blacknose may be reduced by moderate thinning. The proper aeration of fruit is of great importance and can be controlled by the grower if he understands the principles which are involved. The removal of 50 to 60 per cent of the total number of fruits per bunch is advocated by Nixon and Crawford (14) and, in the light of these experiments, such a practice seems desirable. The insertion of wire rings will provide needed aeration for fruits on the inside of the bunch during the critical season of ripening. If there is no rain and the fruit seems to be shrivelling owing to excessive aeration, the rings can be removed with little effort. The protection afforded by paper tubes against rain and birds is appreciated by most growers in the Coachella Valley. Experience tends to indicate that bagging should be done while the fruit is in the khalal stage. A type of bag which allows free circulation of air through the fruit bunch is to be desired.

The wire rings used in these experiments proved to be satisfactory in several ways. They were large enough to be effective; they did not fall from the bunch during picking; they showed little or no depreciation after three years; and they were comparatively inexpensive. ***

***A lot of 260 rings were made by hand at the Citrus Experiment Station at a cost of 8.87 cents per ring. Materials: 100 pounds of soft galvanized iron wire (Washburn and Moen Gauge No. 8) and two bars of "half and half" solder. Labor: 31 hours at 55 cents per hour. Equipment: a heavy wooden block with 18 large nails driven part way in it (used for bending the wire), an electric soldering iron, a vice, hammer, wire cutter, and coarse file.

Most of the methods which were used in these experiments were taken from the common experience of the date growers in the Coachella Valley. The results are not revolutionary in character but tend to strengthen certain ideas which have developed with the industry. Much has yet to be learned concerning the control of fruit spoilage but it is hoped that these experiments will add something to the present knowledge of this subject.

Literature Cited

(1) Brown, J. G. 1920. Rot of date fruit. Bot. Gaz. 69:521-529.

(2) ———. 1921. Date rot. Ariz. Agr. Exp. Sta. Rept. 32:606-609.

(3) ———. 1934. Rot of date fruit. Ariz. Agr. Exp. Sta. Ann. Rept. (1934) 45:77-78.

(4) ———. 1937. Rot of date fruit. Ariz. Agr. Exp. Sta. Ann. Rept. (1936) 47:71-72.

(5) Brown, J. G., and Frederick Gibson. 1922. Plant Pathology. Date rot project. Ariz. Agr. Exp. Sta. Ann. Rept. (1922) 33:240-242.

(6) Cudebec, C. L. 1928. Prevention of rain damage to fruit clusters. Date Growers' Instit. Ann. Rept. 5:8-10.

(7) Fawcett, H. S., and L. J. Klotz. 1932. Diseases of the date palm, Phoenix dactylifera. Calif. Agr. Exp. Sta. Bul. 522:1-47.

(8) Haas, A. R. C., and Donald E. Bliss. 1935. Growth and composition of Deglet Noor dates in relation to water injury. Hilgardia 9:295-344.

(9) Hilgeman, R. H., and J. G. Smith. 1937. The crude fat content of date skins correlated with moisture damage. Date Growers' Instit. Ann. Rept. 14:16-17.

(10) Klotz, L. J. 1931. Investigations on date palm diseases. Date Growers' Instit. Ann. Rept. 8:14-18.

(11) Nixon, Roy W. 1932. Observations on the occurrence of blacknose. Date Growers' Instit. Ann. Rept. 9:3-4.

(12) ————. 1933. Notes on rain damage to varieties at the U. S. Experiment Date Garden. Date Growers' Instit. Ann. Rept. 10:13-14.

(13) Nixon, R. W., et al. 1937. Discussion. Date Growers' Instit. Ann. Rept. 14:19-23.

(14) Nixon, Roy W., and Carl L. Crawford. 1937. Fruit thinning experiments with Deglet Noor dates. Amer. Soc. Hort. Sci. Proc. (1936) 34:107-115.

(15) Postlethwaite, H. W. 1926. Observation on rain damage to dates. Date Growers' Instit. Ann. Rept. 3: 10-11.

(16) Swingle, Leonhardt. 1931. Care of the Deglet Noor date bunches from pollination to picking. Date Growers' Instit. Ann. Rept. 8:1-3.

Interplanting A Date Garden With Grapefruit

By D. H. Mitchell

FOR many years the subject of interplanting a date garden has been of interest to date growers. As far back as 1929 recognition of this interest was taken by the Date Growers' Institute and Robbins Russel presented a paper in which he outlined his conclusions with grapefruit and turkeys.

In 1930 I planted 10 acres of mixed citrus on my place at Indian Wells and much of what I have included in this short paper is the result of observing that planting supplemented by experience gained in managing the Coachella Valley Fruit Co. ranch the past seven years which contains approximately 25 acres of various kinds of citrus trees interplanted among date palms.

Grapefruit seems to thrive among date palms. The trees adopt a more open and spreading type of frame than is the case when not interset, but make a vigorous and thrifty growth.

In listing some of the advantages of interplanting with grapefruit it would be well to point out the following:

(1) Frost protection: Grapefruit trees that had the protection of tall palms suffered very little damage from the 1937 freeze.

(2) Sunburn protection: The exposed fruits on trees planted in the open are often reduced in grade or made into culls by the sun while interplanted trees show little loss from this source.

(3) Diversity: More than one crop on the same acre.

(4) Smooth fruit: Scarred fruit due to wind damage is at a minimum.

(5) Reduced cost: Exact cost figures on growing dates and grapefruit together as contrasted with the cost of growing the same tonnage separately have never been compiled to my knowledge. It seems a safe assumption, however, that there is a decided balance in favor of interplanting.

The disadvantages of planting in this manner are as numerous.

(1) Reduced tonnage of grapefruit: Smaller crops of grapefruit when shaded by large date palms are the rule. Many estimates range from less than half to about two-thirds of a normal load.

(2) Cultivation troubles: Proper cultivation or the production of a cover crop in an interplanted garden is made difficult because so much of the ground is occupied.

(3) Different water requirements: It is the general belief that date palms require more water than a grapefruit tree really needs. While there seems to be no apparent damage to the grapefruit tree by making water schedules to suit the date palm, there may be a day of reckoning later on when the gummosis diseases appear as is the case the other side of the mountains when over-irrigation is practiced. It is possible that our dry air and good drainage will prevent gumming but we do not know.

(4) Lower production and grade of dates: This point is subject to question. I have not found it to be true, so far, but others have reason to believe that the growing of grapefruit did serious harm to both the grade and quantity of dates produced.

(5) Competition: While the grapefruit tree is a shallow feeder and the date palm a comparatively deep feeder, they are in direct competition for plant food as low as the three-foot level. If enough additional food is not added, one or both trees will feel the shortage.

If the question is asked, Is it profitable to grow grapefruit in a date garden, the answer based on this year's prices would be in the negative. The long term view for the future does not look very promising for better prices either. The tremendous acreages set out in Florida, Texas, Arizona and our own state that have not yet reached full production forecast a condition of overproduction for a long time to come. Granted that we can produce a superior quality of fruit and that our costs are low, it is true nevertheless that we are facing a bad problem from a marketing angle. The profit or loss prospect is the most important question to answer before a decision to plant grapefruit trees is made.

By Robbins Russel

I HAVE very little to add to Mr. Mitchell's remarks, and to my own at earlier Institutes, with reference to the interplanting of Marsh Seedless grapefruit in our date orchard. Though ours is the first planting of this character in the Southwest, having been started in 1918, the merits of this type of culture in this country are so involved in the, as yet undetermined, questions of management of dates and grapefruit, that definite conclusions as to its final "place in the picture" cannot yet be stated.

With our own planting we have not as yet learned anything conclusive indicating we are wrong in continuing this "dual cropping." Its management problems are still much as I have covered at earlier Institutes. We do have some considerable data now, however,—though by no means conclusive as yet,—indicating a per tree yield comparable with "straight" plantings of grapefruit. The quality of the fruit produced is at the least equal to that from the "straight" plantings.

Because it is obvious that growers have not devoted sufficient thought to that part of their problem which may be called "what to do with the crop after it is produced" I take this opportunity to present a few observations and facts of vital import to Southwest producers of winter grapefruit especially.

Plantings: (figures from U. S. D. A., June, 1937)

Florida:

Total Orange trees .	14,371,815
" Grapefruit trees	5,747,132
" Tangerine trees	1,653,153
" Citrus trees . .	21,752,100

Of these the percentage not in full bearing yet, is: Oranges 44.4%, grapefruit 34.9%. tangerines 46.0%; average total for all 42.0%.

Texas:

Total Orange trees .	1,849,956
" Grapefruit trees	6,180,505
" other citrus . . .	170,450
" Citrus trees . .	8,201,211

Of these the percentage under 8 years of age is: Oranges 35%, grapefruit 50%, other citrus 28%; average total for all 45%.

Arizona:

Total Orange trees . .	625,145
" Grapefruit trees	1,192,287
" other citrus . . .	24,774
" Citrus trees . .	1,842,206

Of these the percentage under 8 years of age is about the same for all varieties, — being approximately 82½%.

Summarizing the above, in the three great winter grapefruit producing states competing directly with the California winter grapefruit grower (whether he be in the Tulare county area or in the so-called desert area of the Salton basin) **the above figures indicate as of the date of this survey a total in excess of 6,000,000 grapefruit trees not in full bearing, of which more than half are younger than 8 years of age.**

Production (from U. S. D. A. crop report, April, 1938) grapefruit only:

	1936-7	1937-8 (approx.)
Florida . . .	18,100,000 bxs.	13,000,000
Texas	9,630,000	11,000,000
Arizona . . .	1,400,000	2,500,000
California . .	1,550,000	1,917,000

(Approximate net contents of boxes: Florida-Texas 80 pounds, California-Arizona 60 pounds.)

Indications at this date point to a new high in production in Florida for the coming year, unless something occurs to check the crop in prospect; both Arizona and Texas also should show notable gains because of the large percentage of young trees.

Markets

Foreign: So far as any volume is concerned this means the United Kingdom and adjacent European markets. During the period from early October until May, competition is so keen from other sections such as Palestine that, under existing tariffs, freight and other charges, the U. S. produced fruit has been "losing out" steadily for some seasons. In evaluating any sales prices which you may see reported on these foreign markets, it is necessary to deduct in the neighborhood of $2.25 per packed box to convert them to f. o. b. California packing house basis. Once the winter grapefruit shipper does this, the lack of prospects for profitable shipment to these markets is apparent.

Purposely I did not include any figures on foreign plantings of grapefruit, competitive with ours. That these are very large and still increasing, is well known. Therefore, nothing now apparent indicates other than an actual increase, rather than decrease, in the volume of supplies going to markets outside the U. S. A. from other sections of the world.

Domestic: During the past two years I have spent a substantial amount of time in the principal U. S. A. markets from Denver east, north of the Ohio River, during the fall and winter months. I have certain opinions, as a result, which I believe worthy of careful consideration. These are: In certain markets Florida grapefruit is preferred and priced above competitors. In others Texas grapefruit "has the call." In **no market studied** was the general run of California or Arizona grapefruit considered to be other than a rather poor third to that from Texas and Florida. In fact, as the sales results clearly reveal, most of the trade in the important buying centers will not even consider our southwest winter grapefruit until that from Texas and Florida is no longer prime. In other words, the southwest winter grapefruit, where considered at all, is regarded only as an alternate, not as equal or superior, by the trade.

Let me emphasize that I am not talking of the Pacific Coast markets, which are in a different category by reason of natural advantages such as lower transport costs and man-made ones such as various quarantine restrictions.

As to why the trade holds these views, the following are a very few of the apparent or real reasons:

(a) Freight in ventilated cars under the new rates is $448.14 per carload of 462 boxes of California-Arizona grapefruit, to the main markets other than on the west coast. Texas can deliver to Denver for the same rate as can California-Arizona and has rates from 20% to 30% lower to most points, from the west line of Kansas and Nebraska east to Ohio. East of this point the rates by rail are more nearly equalized as between Texas and California-Arizona, — but of course Texas has us beaten even here by truck or boat. Florida enjoys an even greater advantage through the east, than does Texas.

(b) The average grade of fruit marketed from Florida or Texas, is smoother, better-shaped, thinner skinned and of what may be termed "finer texture" than is our California-Arizona Marsh Seedless going to these same markets. Also, so far as my sampling went, it seems to be more evenly segmented. Not even the most prejudiced Westerner could fail to concede that it is juicy and of very fine flavor. I make that statement as a pioneer grower of Coachella Valley fruit, so feel I know what good California-Arizona fruit is like.

(c) The production costs appear to be lower in Texas and Florida. Florida grapefruit growers are reported to make a living at ½c per pound roadside. The Texas situation seems to be much the same. Apparently either of these districts is capable of producing about all the winter grapefruit capable of being absorbed by our present population at present price and income levels, were it not for competitive checks. Costs and quality are all-important considerations, therefore.

Coachella Valley growers also should consider the fact that apparently Arizona growers are able to begin shipment somewhat earlier in the fall and continue it later into the summer, than is the case in the Coachella Valley, thus winning a little, at least, of the higher priced sales which summer usually brings to the citrus producer.

As for the possibilities of manufactured products such as canned juice, "hearts," etc., irrespective of their future the producer must keep in mind that ¼c per pound roadside undoubtedly is a high average price for grapefruit so used; also that ability to can or otherwise "manufacture" the products destroys in large part at least, the barrier which our surrounding oceans have hitherto interposed between our domestic markets and important foreign producing centers.

It is customary to conclude remarks with some sort of a recommendation. I shall not go so far. But I do urge that no effort be spared to develop for our southwest winter grapefruit section, an improved variety, having some of the following characteristics:

More uniform and what is felt by the trade to be typical good grapefruit shape: Thinner skin; finer skin and flesh texture; more even segmentation; smaller average size; later maturity in the season, so that shipment at least until the end of June is possible with consumer satisfaction; more uniform and heavier tree crops (probably this is a factor of soil and farm management, more than variety, though undoubtedly the root stock, at least, has a material bearing on the tree's performance). Such an improved variety would go some way towards equalizing the market possibilities of the grapefruit from these competing districts.

AFTERNOON SESSION

Chairman, Dr. W. H. Chandler, Professor of Pomology, University of California

Maturation and Storage Studies With Soft Varieties of Dates

By R. H. Hilgeman and J. G. Smith, University of Arizona Agricultural Experiment Station

THE majority of the experiments presented in this paper were conducted by the late D. W. Albert who, realizing the necessity for reducing costs of processing, started work on this problem in 1931. With the object of producing a fancy, high quality fresh date having a relatively high moisture content, these experiments were based on a short high heat treatment followed by cold storage, as a substitute for the present commercial methods of extended low temperature processing.

Basic experimental work on artificial ripening was reported by Vinson and Freeman (1) in 1912, and cold storage has been successfully used since 1916. This work was followed by numerous tests conducted by date growers and packing houses, and by the extensive work of Sievers and Barger (2). The experiments conducted by the latter have been largely confined to Deglet Noor dates produced in the Coachella Valley. Normally, the Salt River Valley area has a lower average yearly temperature, and a higher humidity with more precipitation during the late summer and fall than the Coachella Valley. These climatic features are reflected in the later blossoming and ripening of the dates and a considerably higher moisture content in the soft varieties at the tree-ripe stage. Therefore, experiments conducted on Coachella Valley fruit in many respects are not applicable to the same variety when grown in the Salt River Valley.

Methods

Laboratory data was obtained on the fresh fruit in all cases using a minimum of 30 fruits per sample. Longitudinal sections were cut from each fruit so that approximately a 40 gram sample was obtained. After weighing, the dates were macerated under hot alcohol, and the sugar extracted in a Soxhlet extractor using 95% alcohol. Reducing sugars were determined by the Shaeffer Hartman (3) method and calculated as invert sugar. Total sugars were similarly determined after inversion with dilute Hydrochloric Acid. Moisture determinations were accomplished by means of the Bidwell-Sterling (4) method.

The Ripening Process

To further study the changes in composition started by Dr. Vinson, tests were made in 1932 and 1933 on the Khadrawi, Maktoom and Hayany varieties. Studies by Vinson, and by Haas and Bliss (5) on the Deglet Noor have shown that in the early stages of development of the fruit the sugar is largely in the form of reducing sugars. When the date approaches its maximum size a rapid increase in the sucrose occurs while the reducing sugars increase at approximately their former rate. The same type of studies on the above mentioned varieties indicate that a similar condition prevails with them in Arizona. However, the difference between the reducing sugars and the sucrose is not as great as is the case with the Deglet Noor.

TABLE 1

Changes during Ripening

	KHADRAWI				MAKTOOM			
Condition	% Invert	% Total	% Dry Matter	Gr. Sugar per Fruit	% Invert	% Total	% Dry Matter	Gr. Sugar per Fruit
Yellow Green	22.1	30.9	39.7	3.91	15.3	34.1	43.9	6.58
Yellow Brown	23.0	32.8	43.5	4.11	15.8	36.9	45.4	7.53
15% Trans.	24.5	40.9	52.7	4.63	17.4	42.1	51.9	7.92
60% Trans.	35.8	42.8	55.6	4.91	33.0	41.2	51.9	7.95
100% Trans.	38.8	44.7	57.6	4.94	37.22	42.6	52.2	7.83
Soft Ripe	47.1	47.3	59.9	5.33	40.5	42.5	53.1	7.77

Table 1 shows the changes which occur during the ripening processes on the tree for the Khadrawi and Maktoom varieties. Note that as the Khadrawi ripens there is an increase in the percent of dry matter from 43.5% in the khalal stage preceding the formation of translucent spots to 59.9% in the soft-ripe stage. In the Maktoom the increase is not so pronounced, increasing from 45.4% to 53.1%. It was found that if the sugar was calculated upon a dry weight basis there was little difference between the stages of maturity, the Khadrawi remaining at about 76% sugar and the Maktoom at about 81% from the late khalal stage to complete ripening. Inasmuch as the percent of dry matter increased as ripening progressed it might be assumed that ripening was largely a matter of dehydration. It has been pointed out by Sievers and Barger (2) that the sugar percentage of Deglet Noor fruit, when calculated on a dry weight basis, in the full rose stage was generally as high as that of more mature fruit, but that the actual weight of sugar per date increased as the percentage of dry matter increased. To further check this increase 200 dates from each of the progressive stages from late khalal through rutab were weighed exclusive of the seeds. By using these weights it was found that the sugar per date increased in the Khadrawi from 4.11 grams per fruit to 5.33 grams per fruit. The change was not so marked, however, in the Maktoom,

the increase being only from 7.53 grams to 7.83 grams.

From this information it does not appear feasible to pick the Khadrawi until at least the fully translucent stage is reached. The Maktoom, however, could be successfully handled by picking at the 10 to 25% translucent stage. It was further found in the same variety that khalal fruits in the amber-yellow stage early in the season had considerably less sugar than fruit with the same external characteristics late in the season. It is evident then that dates maturing late in the season may be picked considerably greener than those maturing early. Furthermore, this largely explains the fact, as shown elsewhere, that dates picked late in the season store better than those picked early.

fruit had not broken and the texture was still hard and undesirable. Further studies in 1934 gave the same results so this method of treatment was discontinued and only fruit in the fully translucent and tree-ripe stages was used.

Processing

The principle of Pasteurization has been applied to many products and its application to dates was discussed at considerable length by Postlethwaite (7) in 1927 who had developed a high heat treatment for the Deglet Noor at that time. A large number of tests have been made at the Tempe Station in an effort to determine the proper temperature and interval for treatment. The practice followed was to grade the dates and pack them in berry baskets as soon as they were brought into

TABLE 2

Hallawi—120 Days Storage

	% Moisture	General Condition	Fiber	Color	Flavor
20-40% ripe	39.9	Fair Mold	Unbroken	Light Amber	Poor
40-60% ripe	40.1	Good	Incomplete	Light Amber	Fair
70-80% ripe	39.3	Very good	Variable Incomplete	Brown	Fair
Soft ripe	36.9	Very good	Complete	Light Brown	Good
Processed	32.8	Excellent	Complete	Brown	Very Good
Tree ripe 158°-2 hr.	34.9	Excellent	Complete	Light Brown	Very Good

1933	4 tests	Average rating	Fair-good
1934	10 "	" "	Very good-excellent
1935	33 "	" "	Very good
1936	23 "	" "	Fair-good
1937	38 "	" "	Fair

That the above conclusions were correct was demonstrated at the time by a storage test conducted with the Halawi. The object of this test was to simulate Swingle's (6) work with the Deglet Noor by determining the practicability of completing the maturity of partially ripe fruit in cold storage. The results of this test are printed in Table 2. The dates were picked at four stages of maturity: 20-40% translucent, 40-60% translucent, 70-80% translucent, and soft-ripe. They were packed in eight-ounce berry baskets, wrapped with ordinary cellophane and placed in cold storage with no heat treatment. Commercial storage conditions of 32-34° F. with a humidity of 65-72% were the same in all storage experiments. It is of interest that the condition of the fruit after 120 days storage was in direct relationship to the degree of maturity. While the tannin had become insoluble in all samples, the fiber in the less mature

the laboratory from the field. The packed but unwrapped baskets were then placed in a ventilated oven and heated at temperatures of 140° F., 158° F., and 176° F. with time intervals of one to seven hours. Six baskets were used for each treatment in the majority of tests which were confined to the Khadrawi, Halawi, Hayany and Maktoom varieties. In general, the experiments on temperatures show that the higher temperature of 176° caused the fruit to become syrupy and if continued longer than one hour carmelization occurred imparting a scorched flavor to the dates. Only slight differences were noted between treatments of 140° F. and 158° F. for intervals of two to four hours. For longer periods the differences obtained were largely due to loss in moisture from the fruit. This loss of moisture was of marked importance with the Hayany and Maktoom varieties which have a high moisture content (45-50%). The two to four hour treatment at 158° only lowered the moisture content two or three percent and was apparently not sufficient to kill spores and bacteria with the result that frequently mold and fermentation occurred.

The value of this treatment varied considerably depending upon the season. For example, the Hayany in the 1933 season started ripening about September 6 and in the following six week period .41 inch precipitation was recorded with a total field loss of 50%. Of the eight tests made that season, five developed mold and only the regularly processed fruit was satisfactory. The processed fruit had been reduced to a moisture content of 39% while the high heat treated dates had moisture contents of 43-47%. The 1934 season was the best season for the Hayany in recent years. Ripening started August 10 accompanied by generally favorable weather with the result that the field loss was only 10-15%. Nineteen tests were made that year and no mold was found in any sample. Fruit which was treated for the longer time intervals was too dry; the moisture content varied from 37-43% in the different treatments.

It appeared from this data that the condition of the fruit was of far greater importance than slight variations in treatment. The conclusion was reached that Pasteurization treatments would not be satisfactory for commercial adaptation to the Hayany and Maktoom varieties.

Tests with the Halawi were more satisfactory because of the lower moisture content of the ripe fruit. It was found in 1932 (Table 2) that Halawi fruit picked at the fully ripe stage and heated at 158° for two hours was in excellent condition 120 days later and equally as good as the processed fruit. In 1933, 1934, and 1935 tests were made using ordinary and moisture proof wraps. These tests in general showed only slight differences caused by time interval and temperature treatments. Moisture proof cellophane maintained the grade better if the moisture content was 21-24%. If the moisture was as high as 29-31% ordinary cellophane which allowed gradual dehydration in storage was superior. It is evident from these tests that the Halawi fruit may be successfully handled with the Pasteurization process. In dry years a sufficient storage interval must be provided to allow hydration of the fruit.

Work done on the Khadrawi shows considerably greater variations between years than between tests. The following summary of the tests made

from 1933-37 clearly show these deviations.

Furthermore, these differences are not confined to years, but occur within a single season. In 1937 dates picked at intervals during the season were given identical treatment. On February 7 these dates were removed from storage and rated as follows: Sept. 7 test, poor; Sept. 13 test, fair; Sept. 16 test, good; Sept. 30 test, good; Sept. 27 test, fair.

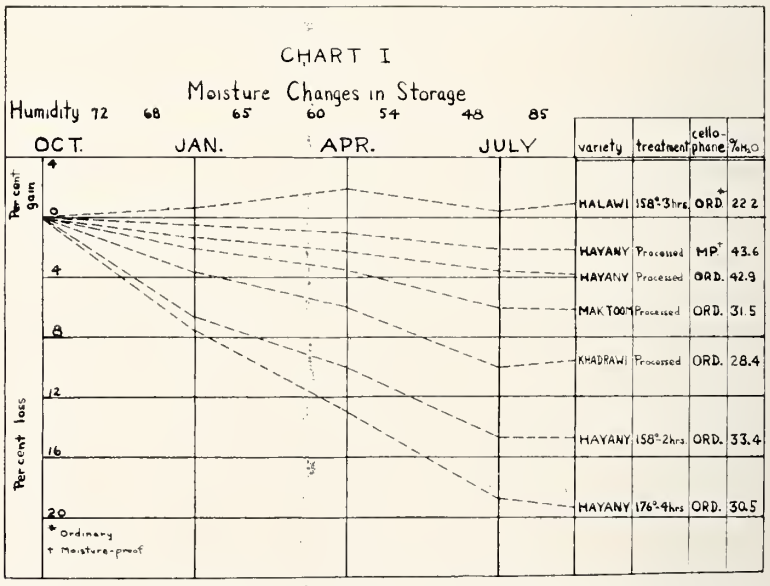
Such variations make it very difficult to duplicate results, however, specific treatments have in general produced specific results. The skin of the dates which have been picked at the fully translucent or hard-ripe stage has a tendency to separate from the flesh; this tendency is not present in the soft-ripe fruit. The formation of sugar spots is considerably greater in the fruit picked at the soft-ripe stage. Darkening of the fruit in storage has in most instances been more pronounced on the tree-ripe fruit. This discoloration appears to be associated with a number of factors one of which is the moisture content of the fruit. Fruit with either a very high (36-38%) or very low (20-24%) moisture content darkened more rapidly than fruit with a moisture content of 26-30%.

The use of moisture proof cellophane has provided some interesting results. If dates having a moisture content of 34-38% are prevented from losing moisture, the formation of sugar spot is entirely prohibited. However, in all cases the rate of darkening was notably accelerated and was accompanied by a discoloration of the flesh and a loss in flavor, which is apparently due to the confinement of certain products within the package. Attempts to absorb these products with soda lime, calcium oxide and different types of paper have not been successful.

In most cases souring and fermentation took place much more rapidly within the air-tight package than in the ordinary cellophane package when stored at room temperature after removal from cold storage. On the strength of this observation the writers do not recommend the packing of soft dates in air-tight containers.

Storage

Studies on changes in moisture content of the date in storage reported by Barger (8) indicated that this is largely a process of hydration. To determine these changes under Arizona conditions, in 1934 tests were made on Halawi, Hhadrawi, Maktoom and Hayany varieties packed in commercial eight-ounce berry baskets covered with ordinary and moisture proof cellophane, the latter sealed with cellulose tape. Forty-eight baskets representing 24 tests were weighed in the storage room each month during a ten-month period, at the termination of which moisture determinations were made in each test. The commercial date storage temperature of 33° F. was closely maintained excepting during the last month. The relative humidity averaged 70% during the first three months gradually decreased during the following six months to 48% and then increased sharply in July to 85% when a quantity of plums were placed in the storage room. The changes which occurred in seven of the tests are shown in Chart 1. Note that the Halawi variety with a moisture of 22.2% gained when the humidity was above 60%, lost at 50% and gained again during the high period in July. In all other tests dehydration occurred throughout the period and at an accelerated rate as the humidity was reduced. Moisture proof cellophane reduced the loss in moisture from the processed Hayany fruit 50% compared with ordinary cellophane. It is evident from the data in this chart that the storage moisture loss of the fruit is in direct relationship to the pre-storage high temperature treatment.



It is obvious that a humidity of 60% will maintain Halawi dates with a moisture content of 22-23% without change. Higher humidities are required for the Khadrawi, Maktoom and Hayany varieties to maintain their original moisture content. It appears to the writers that since sugar spots and crystals were not found in packages sealed with moisture proof cellophane, undoubtedly this type of deterioration could be materially reduced by increasing the humidity in storage to a point at which no dehydration occurred.

During 1937-1938 a few samples were observed at a storage temperature of 5° F. For this purpose a specially equipped electric refrigerator was provided. A heavy accumulation of ice crystals on the coils of this unit necessitated a defrosting and consequent raising of temperature at two week intervals. In spite of the drastic temperature changes brought about by defrosting, dates stored at the low temperature were definitely superior in color to those stored at 32°, particularly those subjected to high heat treatments. No abnormal breakdown in either color or flesh was noted after the dates had been removed from storage at this low temperature.

Summary

1. Delay picking on early ripening varieties particularly early in the season until the translucent stage is reached.

2. No significant differences were apparent between high heat treatments at 140° and 150° for intervals of two to four hours. The amount of moisture in the date is the limiting factor in the success of this method.

3. High heat treatments may be successfully applied to Halawi dates excepting very dry ones when provision must be made for hydration. It is moderately successful on Khadrawi if they are dry. It has not proven

successful with the Hayany and Maktoom except in one year of the five year test.

4. In general, high heat treatments produced dates inferior to those commercially processed at lower temperatures, however, preliminary studies indicate that storage at lower temperatures may give more satisfactory results.

5. Moisture proof containers retard the formation of sugar crust and sugar spot, but accelerate darkening and deterioration in flavor.

6. The relative humidity of the cold storage room should be regulated according to the moisture content of the dates stored.

References

(1) Vinson, A. E. and Freeman, G. F. 1911. Chemistry and Ripening of the date. University of Arizona Agricultural Expt. Sta. Bulletin 66.

(2) Sievers, A. F. and Barger, W. R. 1930. Experiments on the processing and storing of Deglet Noor Dates in California. U. S. D. A. Technical Bulletin 193.

(3) Shaffer, P. A. and Hartman, A. F. 1921. The iodometric determination of copper and its use in sugar anaylsis. Journal Biological Chemistry 45.

(4) Bidwell, G. L. and Sterling. W. F. 1925. Preliminary notes on the direct determination of moisture. Journal Industry and Engineering Chemistry 17.

(5) Haas, A. R. C. and Bliss, D. E. 1935. Growth and Composition of Deglet Noor dates in relation to water injury. Hilgardia, Vol. 9, No. 6.

(6) Swingle, L. 1926. Cold Storage of dates. 3rd Date Growers Institute.

(7) Postlethwaite, R. H. 1927. Treatment of Dates to Prevent Souring and Fermentation. 4th Date Growers Institute.

(8) Barger, Wm. R. 1934. The effect of humidity and containers on dates. 11th Date Growers Institute.

A Further Report On Water Use By Coachella Valley Date Palms

By Arthur F. Pillsbury, Junior Irrigation Engineer, Citrus Experiment Staion, Riverside, California

At the fourteenth meeting of this Institute, the author presented a paper summarizing one year's study of use of water by date palms. This is a further report on that phase of the same project. The work is being conducted by the Irrigation Division of the University of California, Citrus Experiment Station, with the cooperation of the Bureau of Agricultural Engineering, United States Department of Agriculture. Further, the Bureau of Plant Industry has kindly donated laboratory space at their Government Date Gardens near Indio.

Last year it was stated that the one year's results reported were of insufficient duration to give anything but rough approximations. Although the results obtained in the second year substantiate those of the first, additional investigations are required to determine if the irrigation treatments employed are adequate in all plots to assure consistently good yields of high quality fruit.

As stated in 1937, the method of procedure in this work was to select plots for soil-moisture study in what appeared to be good average commercial Deglet Noor date orchards. In these plots the practice has been to follow closely the irrigation procedure of the grower. Where any modifications of that practice have been attempted, such modified treatments are also applied to guard rows on each side of the selected plot. In general, the objective has been to keep ample moisture in the soil at all times.

The total amount of water applied to the selected plot is carefully measured with a weir at each irrigation, and every effort is made to spread that water evenly over the plot. Then in each interval between irrigations, three sets of soil samples are taken to determine the rates of moisture removal from the soil at various depths.

Sampling is started at a datum just below the mulch, that surface soil where cultivation removes all roots, and where most direct evaporation occurs. Below that datum, cores are removed for each two-foot depth. Samples are taken to a depth of 8 feet at the first and last samplings of each interval. They are taken to a 4-foot depth at the second sampling. Soil-moisture content is computed from an average of the findings of 10 holes at each sampling. This number is barely sufficient to give satisfactory results in the variable and stratified soils of Coachella Valley.

Interpretations of a Typical Soil-Moisture Chart

A chart on which irrigations and average soil-moisture content of each depth zone for each sampling period are plotted is prepared for each plot. Such a chart, of Plot 10, is shown in Figure 1. For each irrigation date, vertical lines are drawn representing the resultant soil-moisture increases. Points representing moisture percentages are then connected, and the curves extrapolated until they intersect the vertical lines.

This chart illustrates typical confusing factors which are encountered with soil-moisture investigations in Coachella Valley. If conditions are such that the trees can remove water from the soil at a uniform rate, and if soil moisture is readily available within the moisture range represented, the curves of moisture extraction should be straight lines. Where they are not, under such conditions, the moisture percentages are obviously in error. Fortunately such errors are not cumulative and cannot greatly affect the results if averaged over a sufficiently long period. As illustrated for the interval between May 4 and 24, moisture appeared to increase between the second and last sampling periods, when it must have decreased. In this case adjustment was made to give each of the percentages weight and the curve was drawn as a straight line, which it probably approached.

Another type of error is illustrated in the interval between the irrigations of February 25 and March 25. There was probably some downward gravitational movement of water between the first and second samplings, so the percentages found for the first period are disregarded for the 0-to-6-foot depths. For the 4-to-6-foot depth it was necessary to assume that the amount extracted was 15 per cent of the total, which is the percentage normally extracted from that zone.

It is regretable that such assumptions must be made, and this chart should demonstrate that soil-moisture measurements give relative values. But when rationally interpreted, re-

sults obtained are of an accuracy adequate for practical needs.

As shown on the chart, there was a 5½-month interval in which this plot was not irrigated. Changes in the pipe line system necessitated this drastic treatment, and data from October to February are not included in the averages for consumptive use. The average soil-moisture content was always above the permament wilting percentage ("PWP" on figure 1). Rates of use, however, were lower than for other plots and increased rapidly after February 25. It is possible that soil in immediate contact with the roots was quite dry and only gradual movement from surrounding moist soil took place. Measurements made are, of course, only of average soil moisture. These data present some evidence that average soil moisture cannot safely be reduced to the permanent wilting percentage without making less moisture available to the trees. These curves will be referred to again later in relation to growth response.

Use of Water

Consumptive use, as stated in 1937, is taken as the amount of moisture removed from the soil mass sampled in the intervals between irrigations. The average consumptive use for all plots for both years is 7 feet in depth per year. Significant differences between the plots have not been evidenced, except that there are indications of a slightly lower use in one plot on heavy soil. Consumptive use was only 6 feet for the one year of record, but irrigations may not always have been adequate. Range for all plots was 6 to 7.3 feet per year.

Table 1 summarizes average consumptive use by months. Given also is the adjusted amount of water actually applied. Consumptive use has averaged 78 per cent of the amount of water applied, excepting one plot on which efficiency records are as yet inconclusive. For the most part, it can be said that 78 per cent of the amount of water applied has been accounted for in soil-moisture increase. In other words, it was necessary to apply about 9 feet of water per year to obtain a consumptive use of 7 feet.

When there were significant indications of a soil-moisture deficiency on any plots during any interval, the amounts obtained were not included in the above averages. Likewise, there has been a period on one plot when water was applied in excess. This resulted in slow downward drainage of water all through the intervals between irrigations, and soil-moisture figures did not represent consumptive use alone. Tree growth was vigorous and the soil was sandy in this plot. Water was being applied at the rate of almost 11 feet per year. From August, 1937, until last January there was slow, continuous percolation below the root zone. The above averages do not include these use figures.

Some leaching below the root zone is recommended to keep salt concentrations below toxic limits. Yet leaching should not be sufficient to remove valuable plant nutrients. Irrigation treatments should be such as to maintain a proper salt balance. This phase of the irrigation problem is being investigated in the plots concerned in this study.

Depth of Root Activity

The amount of moisture removed from the soil at various depths is an indication of the concentration of active roots at those depths. Percentages of total root activity as determined by soil sampling are fairly consistent for the different plots except within the first four feet. As irrigations normally wet to at least 8 feet, such differences are not important. Average percentages for each depth are shown in Table 2. Preliminary work in 1932 indicated that there is probably some root activity below 8 feet, but it is not measureable by the methods employed.

TABLE 2
Depth of Root Activity in Date Plots

Depth	Per cent	
0′-2′	50	
2′-4′	30	80
4′-6′	15	
6′-8′	5	20

Plant Response to Soil Moisture

A comprehensive investigation of plant response to soil-moisture involves the setting up of differential treatments in a uniform planting. Plots must be large enough to minimize the variability of individual plants, yet small enough to minimize the effect of soil and nutrient differences. There must be adequate guard rows receiving the same treatment. Cultural practices involving fertilizers, cultivation, cover-crops, pruning and thinning must be the same for all plots. Plant growth, yield, and quality records must be kept over a period of years. And irrigation treatments must be varied to produce distinct and known differences in the soil-moisture ranges to which the plants are subjected, in all parts of the root zone.

The University does not have the land or facilities to conduct such an investigation. Further, information would not be available for a considerable period. With pumping costs high and the Coachella branch of the All-American Canal being designed, it is felt that there is immediate need for a practical answer to the question of the water requirements of date orchards.

This present work relies heavily on the soil-plant-water relationships evolved by the University from fundamental investigations elsewhere. These soil-plant-water relationships do hold true, but proper cognizance must be taken of the limitations inherent in the measures involved.

Soil moisture has been found to be equally available to plants whether the soil in contact with the roots be near its field capacity or near its permanent wilting percentage. For many soils and many crops, the soil is sufficiently uniform and root distribution is such that moisture is readily available to plants until the average moisture content is actually down to the permanent wilting percentage. If, in differential treatments under such conditions, the soil is never allowed to dry below this percentage, there have been no significant differences resulting. But it is not true that the average moisture content can be reduced to the wilting point in all soils, in all localities, or with all crops. Certainly, it cannot be presumed in the present work that such dry treatments would not have disastrous results. Where water use is high, as in Coachella Valley, there must be adequate moisture in all parts of the soil, especially in the heavily-taxed zones of high root concentration.

Therefore, in the present work it is essential to look elsewhere to con-

TABLE 1
Average Consumptive Use and Adjusted Amounts of Water Applied on Coachella Valley Date Plots

1936-1938 Inches depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot	Total in ft.
Consumptive use	3.7	4.4	6.0	9.8	8.9	10.5	9.8	10.2	7.3	5.8	3.8	3.0	83.2	6.9
Water applied	4.7	5.6	7.7	12.6	11.4	13.5	12.6	13.1	9.4	7.4	4.9	3.8	106.7	8.9

firm the adequacy of irrigation treatments. With this end in view, soil-moisture curves are carefully inspected for rough indications of decreasing rates of use prior to irrigation. In Figure 1, for example, the rate of use steadily decreases from September to February. This is partly a seasonal decrease but, as the rate drops below that of any other plots, it is questionable whether or not there was sufficient moisture available.

For a further check on soil-moisture adequacy, growth of the new center leaves of the palms has been measured, as explained last year. A fine wire is attached to a new center leaf and run down the trunk through screw eyes. From the end of the wire a nail is suspended. Measurements of growth, the distance to the nail from a datum point below, are made on each sampling day. These growth measurements have shown some inconsistencies, and some refinements in the method are desired. But they have given results which help interpret the data.

Growth rates, plotted from such measurements are shown at the bottom of Figure 1. These rates appear to have increased after a number of irrigations. It is probable that these high rates may indicate a previous inadequacy of soil moisture, but the data are not entirely conclusive. In most cases, it will be noted there was no apparent change in rate of moisture extraction.

Throughout the interval of September 9 to February 25, growth continued at as rapid a rate as prevailed on the other plots. This would indicate that there was no soil-moisture deficiency sufficient to slow up growth. However, the increase after February 25 indicates a response to soil moisture. No explanation of these apparent contradictions can be offered at this time.

There was no evidence of increased growth rate after any irrigation on the plot previously mentioned which received an excess of water. It will be recalled that the excess water was drained below the root zone without apparently increasing the consumptive use. With an excess of water, it is significant that this plot showed no growth response to irrigations.

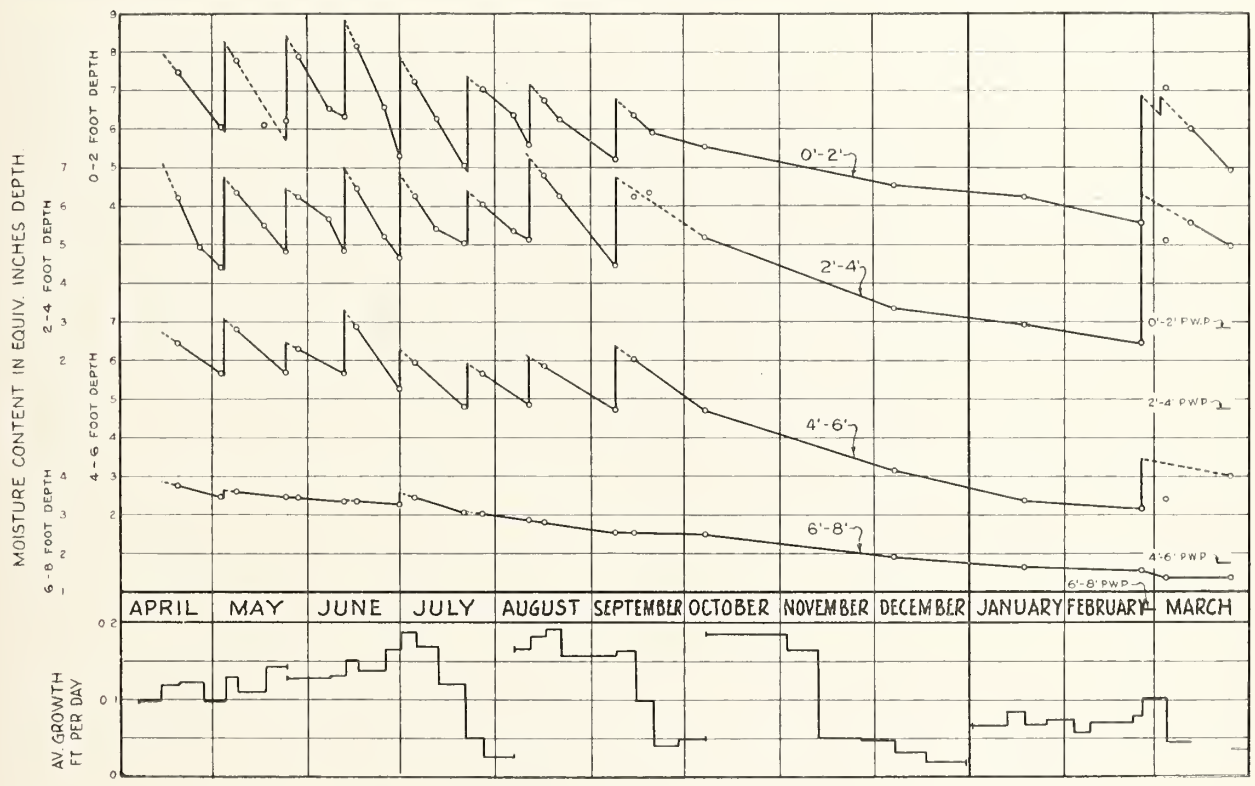


Figure 1. Typical soil moisture and leaf growth chart. Plot 10. 1937-38 season.

Conclusions

It is the purpose of this project, then, to collect quickly such data as are necessary to provide growers with the assurance that a given amount of irrigation water is adequate for their orchards. If care is exercised in irrigating to obtain uniform distribution, the use of a total of 9 feet per year should be sufficient for all needs of the plantings. This should be applied in amounts per month as indicated in Table 1. These data are, of course, subject to some modification as the project progresses.

Frequency of irrigation and amount to apply at each irrigation will vary not only with the season but also with the soil of each particular planting. Experience on this project indicates, however, that applications 6 or 7 inches deep with a minimum interval of two weeks in summer are entirely adequate on the sandy soils. On finer soils the minimum interval may often be somewhat longer with heavier applications.

Practical experience of the local growers seems to indicate that maintenance of entirely adequate irrigation treatments is essential to procure the greatest yield from the fruit marketed. No information can be obtained from this work as to the relation of savings from using less irrigation water to the decreased value of the harvested crop. Any conclusive data of that nature will have to come from a long-time experiment with differential irrigation treatments.

Cold Storage of Date Pollen

By Carl L. Crawford, Assistant Scientific Aide, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, Indio, California

DATE pollen is often needed early in the season before male blooms have opened. In some cases growers, following Old World tradition, have resorted to the use of pollen held over from the previous year. In routine tests made at the U. S. Experimental Date Garden in the past, date pollen held one year at room temperature has always failed to set fruit when applied under bags, which insured against the entrance of fresh pollen.

Furthermore, in 1924 A. B. Stout (3) reported on results of 464 laboratory germination tests from 29 different lots of date pollen stored for one or more years by date growers of the Coachella Valley. Of the thousands of pollen grains counted, only three germinated; and these he believed to have been stray grains of fresh pollen which was being tested in the laboratory at the time.

Since Albert (1) reported somewhat greater germination of pollen held one year at 34° F. than of pollen held at room temperature, it seemed possible that a temperature lower than 34° might be better for date pollen storage. Therefore, pollen, held one year at 8° F., was compared with pollen held at room temperature. Inasmuch as growers are interested in the action of pollen in producing fruit, the effect of the storage temperatures was measured by determining the percentage of flowers setting fruit.

In March, 1935, and in March, 1936, pollens for these tests were collected and dried as for ordinary pollinations. They were then put in glass vials between layers of cotton, and the vials closed with cork stoppers. Some of the vials were placed in a cold storage locker with a temperature of approximately 8° F. The vials were left in cold storage until a day or two previous to use the following spring. The pollens stored at room temperature were held in the laboratory, some of them in glass vials and some in sealed glassine envelopes.

A separate inflorescence was used for each test; and the pollens held at different temperatures were compared by applying them to different strands on the same bunch. One set of strands was left unpollinated in each inflorescence as a check on technique and on possible contamination by air-borne pollen. The technique was similar to that developed by Nixon (2) for applying several different kinds of pollen to the same cluster, as reported at the Third Annual Date Growers' Institute.

The percentage of flowers setting pollinated fruits is based upon counts of flower scars and fruits on each set of strands, made when the fruit had reached full size. Table I shows the results of the experiments in 1936 and 1937 with pollens which had been stored for one year.

The fact that pollen held at room temperature did not result in appreciably greater set of fruit than the unpollinated "check" is in line with earlier results, which showed that pollen stored one year at room temperature was not effective. The fruit on those strands probably was due to air-borne fresh pollen. The pollen held one year in cold storage, resulted, in each comparison, in only a slightly lower set of fruit than did fresh pollen. However, this pollen, held one year in cold storage, gave an average set of fruit of approximately 57 per cent in the two years' experiments, and such a set of fruit would normally give a satisfactory crop.

The two years' results indicate that, where it is desirable to hold pollen from one spring to the next, pollen stored in stoppered bottles at a temperature of about 8° F. may be expected to give a satisfactory set of fruit.

Literature Cited

(1) Albert, D. W. Viability of pollen and receptivity of pistillate flowers. Date Growers' Inst., Coachella Valley, Calif., Ann. Rept. 7:5-7. 1930.

(2) Nixon, R. W. Experiments with selected pollens. Date Growers' Inst., Coachella Valley, Calif., Ann. Rept. 3:11-14. 1926.

(3) Stout, A. B. The viability of date pollen. Jour. N. Y. Bot. Garden. April, 1924.

TABLE I

Average Percentage of Blossoms Setting Fruit, Following Use of Fresh and Stored Pollens

Year	Unpollinated (Check) (Per cent)	Pollen Stored at Room Temperature (Per cent)	Fresh Pollen (Per cent)	Pollen Stored at 8° F. (Per cent)
1936	1	3	69	65
1937	0.4	0.5	64	50

Merchandising California Dates

By Edwin Humason, Sales Manager, Calavo Growers of California

THERE is a vast difference between "merchandising" California dates and "selling" California dates. "Merchandising" means completing the cycle from the grower's trees to the consumer's table, for every pound of dates raised by the industry, and at prices net to the grower that will permit him to stay in business on a basis of reasonable return on his investment and his labor, plus a proper expenditure to reasonably safeguard that a given garden's production will be of average grading and quality. That, of course, can be taken merely as the theory from which the operations shall start, but at the same time, it should always be remembered that some farms in every industry will always be sub-standard when compared with the industry's averages and, of course, such substandards are always directly traceable to such factors as poor soil, poor location, poor cultural knowledge and poor cultural practice. So much for the theory of "merchandising."

"Selling" California dates, however, is something entirely different. Retailers, wholesalers and brokers "sell" dates—but only to the extent of their profitable demand which is almost invariably limited by their asking price and which bears no responsibility to the complete "sell out" of the entire crop at satisfactory prices to the producer. Thus, it can readily be perceived that individuals "sell" dates but only the industry itself, or possibly the government, can "merchandise" the date crop. "Selling" is an individual func-

tion and may or may not be accompanied by a sufficiency of profit to warrant that individual's continued sales effort. If that individual effort cannot sell a sufficiency of dates to recompense for the efforts and interest, dates are promptly discontinued. If the individual is satisfied with his present volume to the extent of retaining his interest, in his relatively small way he will perhaps attempt some of the merchandising functions, with the hope that these added efforts will sell even more dates for him and thus create a greater profit in his cash drawer. There are many such merchants among the retailers and the wholesalers, but unfortunately, those extra efforts along "merchandising lines" are few and far between in the food industry and, not less important than that, whenever such efforts can be enjoyed, they necessarily must be individual and not collective. Thus, while a good idea or a good effort may be born, as a general rule it is jealously guarded for the individual's personal profit which, aside from being a perfectly natural human reaction, is somewhat buried in one of the perhaps 15,000 retail outlets through which your California dates are merchandised.

To a great extent, therefore, it can be said that "merchandising," is universally applied ideas. Ideas for universal application must of necessity be planned in advance if they are to have a chance of demonstrating their effectiveness. Such plans, of course, must be laid out by competent people with a background of successful experience. Even then, such plans can accomplish little or nothing, unless they are backed by intelligent and physical efforts of a merchandising organization. Plans are made at a desk. They are carried out by a sales organization actually in the field and the final results depend entirely on the coordination of these two factors.

It can therefore be said that merchandising the California date crop must necessarily start with the estimates of the total annual production, which must be broken down into the estimated tonnage of the various grades of merchantable dates. "Planning" next studies, analyzes and compares these production estimates with previous production estimates. "Planning" next dovetails those factors with sales and net sales prices in all national markets of previous seasons and winds up with an estimated sales quota, by territories or cities, which is estimated will consume the current crop. The planning next, is, "what will the consuming public pay for this merchandise for the number of pounds of production that the growers necessarily have to sell?"

At this point the "planning" arrives at the approximate figure that the average American housewife can be expected to pay the retailers for this crop. An average profit margin of 30% to the retailer and 12½% to the wholesaler, when deducted, leaves the approximate f. o. b. average price.

At this point, the setting of the asking prices really starts and the only value of that average f. o. b. price is to merely have something basic from which to start. I'd like to call your particular attention to the fact that so far we have not as yet brought into the price planning, any certain or given amount that the producing industry feels the grower must have in order to continue operations. We will get back to this factor a little later. Too, at this point it should be readily perceived that there really are good basic reasons for cooperative marketing, as individuals cannot possibly have all these factors at hand, but like prices that the grower must have to stay in business, we will also get back to the cooperative marketing point a little later.

The "planning," now that it has reached the stage of an average f. o. b. return by grades, must then estimate such items as transportation charges, cold storage charges, local trucking charges and the possibility of spoilage. At this point the price planning is held in abeyance to discuss advertising. The "planning" must then select one or more of the many types of food advertising and must prepare a budget to dovetail with the estimated amount of money to be invested in advertising, which must then be compared with the industry's ability to pay for that investment. This completed, and after deductions for the advertising investment, the next step is estimating the various percentages of the various grades that require packaging and this, of course, is followed by estimating the costs of cleaning, sorting, grading, and local trucking from the garden to the packing house.

After all of these deductions, what is left is the amount of money per pound estimated as "net to the grower at his ranch." At this stage we reach the most important point in the relationship between the producer and the consumer. If this figure net to the grower is as much or more than the growers of the industry feel is capable of showing a reasonable return on their investment, their labor and their cultivation costs, everybody is happy, as the housewife buys the total crop from the retailer who, in turn, makes his fair profit margin of 30%, while the wholesaler does likewise, with his profit margin averaging 12½%, and the employes of the packing houses receive their salary checks for their labor with due regularity.

On the other hand, if that figure net to the grower is not enough to give a reasonable return on the grower's investment and his labor and to permit him to give the proper cultural care to his production, we invariably find an unhappy community and, of course, for very natural reasons. If that figure net to the grower is too low, the "planning" must then re-analyze all estimates, with the hope that the re-analyzation will find savings in operating costs and/or upward adjustments in the estimated price that the consuming public will pay for the merchandise.

You will recall that a few minutes back we were discussing various deductions and we made reference to the fact that those deductions would be there, irrespective of the net price to the producer. Now, I realize perfectly that such statements must necessarily fall on unwilling ears when the audience is made up primarily of producers. Most producers will insist that that method of merchandising is backwards and that the only correct way is to start with the net amount of money that the producer must have and then add such various charges, until the final figure that will be charged to the housewife is reached. It seems to me that an individual's opinion as to which of these two methods is correct, depends almost entirely on whether the individual is a consumer or a producer. It is possible that the producer's idea is the correct one, but against that, is the fact that it has **never been known to work.** One of the best evidences of the practicability of the "consumer's-ability-to-pay" theory, is that our present federal government, which has been trying so desperately to assist the farmer, hasn't even given a thought to starting with the farmers' necessary price and then adding on, to eventually find a price for the consumer, but instead has tried to augment the price that the farmer did get, with various types of subsidies to make up the deficiency. We can therefore form an authoritative statement that

pricing for California dates, must necessarily start with the price that the consumer can reasonably be expected to pay for the entire California date crop and then figure back to the expected net return to growers at the garden and, for any differentials that are necessary in the price at the garden, the merchandising plans must necessarily adjust to the best of the planners' ability.

From these factors therefore, we have only one conclusion; **the California date industry itself is the only one who can "merchandise" the California date crop.** That means cooperation among the producers who comprise the California date industry. That means that at least 85% of the production of the California date industry should be in the hands of "men who will cooperate," one with another, in order that the most dollars can accrue to the California date growers. Too, it should be remembered at all times, that **men** cooperate and **not** the products that they raise. Now, let's sidetrack this theory of cooperation and cooperative marketing for a moment and consider some of the factors that should lead **all** growers into a cooperative marketing deal.

First, we would say that it must necessarily remain unchallenged, that controlled production, controlled grading and controlled shipments to market, will control asking prices, whereas, if **every** producer attempts to market **in his own way and through individual channels**, there can be **no** control whatsoever and merchandise that would readily lend itself to cooperation is unnecessarily competing with itself to the end that the **only** result can be disastrous prices to the producers. While we said a little while ago that only men can cooperate and not products, we still must remember that certain products lend themselves for cooperation in far greater degree than others and, among those products is the California date and we feel that this is due principally to the limitations of the producing areas.

In analyzing this product, we find we have both a food and a confection. That is outstanding. In addition to that, chemists tell us that it is well supplied with many of the important food elements. As a food and a confection, its scope of utility is more broad than most products of the soil. Its competition is largely limited to unsanitary foreign production of considerably lower average quality. Its cost of production and cost of sale, tends to make for a consumer's price which, while relatively high, is nevertheless certainly within the bounds of the average American housewife to purchase amounts several times the average crop size of the past few seasons.

Now, you might ask, "What are those prices that the average housewife can pay?" The only answer is that "it all depends upon certain things." Those things are first, cooperative marketing and its percentage of crop control. No. 2, the amount of advertising. No. 3, how the product will be packaged in the future. No. 4, whether or not certain costs now present can be materially reduced and, among those costs, are grading, packaging and packing, traffic and public cold storage. Five, whether or not better cultural care will increase the quality, or both.

If you take a price of 18c per pound that Mrs. Housewife will pay, which after allowing a maximum of 30% average retailer's profit, 12½% wholesaler's profit, 15% merchandising and distribution costs, a total of 3½c per pound to cover grading, packing, freight and icing charges, and approximately 1c for advertising and cooperative organization maintenance, it will leave a figure net to the grower at the garden of 5c. Now, please do not misunderstand my position on these two figures of 18c for the housewife and 5c to the producer. Those are **not** my ideas and they are used here merely as **an example** based on the past season's crop and the fruit contributed to United, which is admittedly of poorer quality than normal seasons. If improved quality and better grades are established, it would seem that the American public will consume far larger quantities of California dates than have been produced for the past four or five years at an average price of better than 18c per pound. Then too, it is possible that some of those costs between the 18c and the 5c figures of this past season, which are admittedly low, could be reduced by perhaps 1 to 2 cents, all of which will increase the return to the grower from 5c, to 6c or 7c, or a twenty to forty per cent increase in growers' dollars over the five cents figure. I do not confess to know whether 5c net to the grower for his crop is sufficient or not, but it's **reasonably** safe to say that it is more than this Valley's date crop as a whole have produced to all growers net at the garden, for some years back and can be considered a good price considering it's United first year's attempt at marketing dates.

Assuming that these two price examples are reasonable, it would certainly seem that the California date industry picture for the future is not only rosy indeed, but indicates that continued improvements can be made, if certain things are done. With that thought in mind, let's analyze some of the more important factors that have a direct bearing on how the producer can secure more money for his dates. To me, it appears that there are three ways that will definitely render more dollars to the date producers.

Number one is greater cooperation; number two, reduce grading, processing and packaging costs down here in the Valley, and number three is more advertising of California dates.

In my opinion they should be placed just that way for the order of their importance. I repeat: greater cooperation; reduce Valley handling costs; and only after these two have been accomplished, would it pay to do more advertising.

Point number one—that of closer cooperation among producers—should, if common sense is used, be passed by without additional remarks. Unfortunately, it doesn't work out that way, so it seems well worth a few extra minutes here to discuss greater cooperation. A year ago, as most all of you know, the average cash returns to the producer in this industry were woefully inadequate. At that time, quite a number of the larger producing independents and the existing growers' cooperative marketing organization, got together and succeeded in working out some perfectly feasible and workable plans. They were not perfect by a long shot, but time was the important factor and, from my experience in cooperative marketing organizations, I would say that most excellent work was done and results accomplished, in an extremely short period of time. It strikes me that these folks, along with the other producers who subsequently joined with them, are to be congratulated on the good, sound, common sense that they exercised and the complete burial of hatchets that in some instances had been ground to a very fine edge, over a period of seven or eight years of strife. This group did a tremendous amount of work and successfully so, in this very short space of time. Among the 1,001 functions performed, they appointed our organization as their sales staff.

It was mutually felt that our organization of approximately 125 sales representatives, scattered throughout 50 branches, from Seattle to Atlanta and from San Diego to Portland, Maine, would prove advantageous to the date growers in three ways. The first, it was felt that the standing of our organization with the trade of the country was established and, having handled dates as a sideline for the previous four or five years, we would not be totally unfamiliar with your product.

Secondly, such sales staff could be employed on a percentage basis and thereby eliminate the customary fixed charges for salaries, branch office maintenance, travel expense, off-season costs, etc.

Thirdly, Calavo Growers was in a position to finance advances to the growers, advances to cover packing house costs, to cover freight, icing and cold storage charges, as well as monies necessarily invested in advertising the product.

How well the sale of this year's date crop has been done cannot as yet be answered. Last September 1, the date industry faced the greatest carry-over in its history and unfortunately, 79% of this carry-over of over 50,000 cases was in hydrated dates one year or more old; 12% was in choice grading, making a total of 91% of the carry-over in the poorest grades, which quality was further reduced by reason of the age of the hydrated. At this time, 95% of those dates **have been paid for** and the cash return to the Valley today for that portion that has been paid, is exactly $1.50 per case; the average weight of cases, 13.8 pounds. This is a return to the Valley shippers of 10.9c per pound on this carry-over crop, from which transportation, some cold storage charges, grading, sorting and hydrating charges must be deducted. So much for the carry-over crop, but in passing, we have been informed that that was considered a very good job, considering the age of the fruit and the fact that 91% of it was comprised of the two lowest grades.

Of this year's crop at the end of March, approximately 76.000 cases had been sold which, added to the carry-over, makes a total of approximately 126,000 cases sold as of March 31. It is estimated that 83,000 cases remain and, out of this 83,000 should be reserved a carry-over for early fall sales, and it therefore can be estimated that approximately 55,000 cases of this current crop, 65% of the sales have been in the Hydrated and the Choice grading, which indicates that the greater sales pressure has been placed on these two grades, which are the harder of the four grades to sell by reason of the lower average quality. Of the dates that were estimated as necessary to sell this year, totaling 70% have been sold against approximately 63% of the year. We would say that we are a little behind in selling the crop, as we feel that at this season of the year about 80% of the dates should have been sold. We expect, however, to pick up this additional percentage.

Of the 76,000 cases of current season's crop that has been sold as of March 31, the average price that Calavo has received is $2.04 per case and the average weight of the cases sold has been 14 pounds. If we assume that the remainder of the crop that is yet to be sold, will average $1.80 sales prices against the $2.04 sales price that has already been received, the members of United should receive an average of more than 5c per pound for all of the dates shipped through United, and this figure should be on the basis of the dates being picked at the garden. Now, please remember that those are **not** promises. They are merely the best eatimates that we can make at the present time.

Too, during this first year, several important trade abuses which have sprung up over the past seven or eight years, have been corrected. First, is that almost 100% of these 126,000 cases of dates **have been sold** and **not consigned.** Had we continued with the date industry's previous consignment and/or protection policy, we would undoubtedly have less dates in our hands today **but** who would know how many thousands of cases would be returned starting about June 1st. Next, we have entirely eliminated all "free deals" that were oftentimes tied up with advertising. Too, the good old 2% cash discount, is now gone for good. In addition to that, the average profit margin to wholesalers has been reduced from 15% to approximately 12½%.

Now, that is the record of the first year. We have been told that such improvements will undobtedly reflect increase over the average prices received in past years by the majority of the growers but it **may not be** as much as **some** have received. Too, we have been told that, as an average, it undoubtedly will bring more cash dollars to the Coachella Valley for the date crop. It should be remembered that these estimates are in spite of the heaviest carry-over crop that the industry has known and in spite of a cooperative marketing deal that had many loopholes in it, which was directly traceable to the lack of time during the organization stage; too, it should be remembered that many obstacles were created by leaks which permitted fruit that should have gone into the dry pool, to be hydrated and sold in competition with this merchandise, and last, but certainly not least, it should be remembered that the sales staff you employed this year was in its baptismal season as the major factor in the California date sales deal. Those are all obstacles which can and will stand improvement as time progresses. What could more clearly demonstrate the effectiveness of closer cooperation than this, if the producers' dollars are to be increased.

Now, the second point in getting more dollars for the growers is that of reducing the cost of handling, packing, packaging, grading, etc., here in the Valley. One of the major factors in this, I believe, is that of too many organizations. As it stands now, we have United Date Growers of California, Covalda Date Company, California Date Growers Association, the dry pool and some 14 or 15 additional packing houses. It would seem perfectly logical that with closer cooperation, all of these various functions could be under one roof and under one organization. Too, it would seem logical that such a setup would materially reduce operating costs in actual dollars and, at the same time, increase efficiency, which is another way of reducing dollar operating costs. In increasing efficiency, the most important point would be the improvement in the uniformity of grading, which would result in a considerably improved average sales price. If it were possible to have one great co-op, the present average grading, cleaning and sorting cost of 2½c per pound could be reduced, local trucking could be materially reduced, packaging costs could be considerably reduced and material improvements and uniformity in the grading, boxes used, the brands, through the elimination of leaks of No. 2's and culls to compete with marketing of the better grades of dates and too, great savings could be made in cold storage. At the present time 100% of the production of this Valley pays a profit to public cold storage companies, some time during the year. Too, when such storage is purchased, it must be remembered that it is the

hit-or-miss type insofar as being good or bad for this particular product is concerned. Without delving too deeply into construction and engineering, it would seem to be an excellent paying venture for the growers themselves, if and when they have formed a strong cooperative, to build their own refrigeration plant to carry approximately three million pounds and to be equipped with all temperature and humidity controls and with possibly four or five individual coolers within the one plant for the best storage of the various grades, under the assumption that different temperatures and humidities are better for certain grades. With a plant of this type, a preliminary grading could be made of the fruit when it was delivered by the producer to the packing house, and then stored in the plant. In this manner, the length of the use of packing houses would be increased and, instead of using packing house facilities for two or three months under peak-load conditions and peak-load staff, the use of the packing house facilities could be lengthened to possibly six or seven months, which should have a tendency to materially lower cleaning, sorting, grading, packing and packaging costs.

We understand that the average cost of receiving, cleaning, grading, packing, but **not** packaging, is 2½c per pound, with some charging as much as 2¾c. In my opinion, this cost must necessarily be reduced and I say this from the economic side. It would seem that 1¾c should be maximum for this service. The difference between 2½c and 1¾c is, of course only ¾c, but by the time the retailer's profit on the ¾c is added on, plus the wholesaler's profit margin, plus the distribution profit margin, we find that ¾ of a cent has jumped to more than 1½c per pound **extra** that the housewife necessarily has to pay. Now, if we go back to the example we used a few moments ago of 18c to the housewife, the lowering of this cost at Indio would result in giving the housewife an average price of 16½c for California dates and it is obvious that she will buy many, many more pounds at 16½c than she would at 18c. Or, another way of looking at it is, if the housewife will continue to purchase the crop at 18c per pound, this reduction in cost at Indio will increase the net return to the producer from approximately 5c to a little better than 6c, or a 20% increase in the number of dolars received by the grower. Three quarters of a cent per pound doesn't seem very much when you look at a penny, but it is a tremendous sum of money when you add them all together and distribute to the growers for every pound raised. In my opinion, the cost of preparing dates for market here at Indio is too great and must come down. It would seem that greater cooperation would, in itself, be the principal factor in reducing these Indio costs.

The third factor in bringing more cash dollars to the grower is that of enlarging the scope of advertising of California dates. Advertising, as a general rule, is misunderstood and, in the minds of most of the public who do not follow sales work for a livelihood, it is something that everyone immediately agrees should be done, but, because it is only vaguely understood, very few people will want to assess themselves to do it. Advertising, to successfully accomplish its purpose, must necessarily be an **investment.** Whenever it becomes an **expense** instead of an investment, it should be immediately discontinued. Advertising **cannot** assist in selling a product that is **not good** or, that is not a fair return on the money paid for the product by the buyer. This is best recalled to memory by the hundreds of brands of automobiles that have been on the market for the past 20 years and that were advertised heavily but still today are no longer in existence. There was the Chandler, the Cleveland, the Stutz, the Pierce Arrow, the Maxwell, the Dort and hundreds of others. It matters not whether those cars were priced too high, because the manufacturing costs at the factory were too great, or whether the factory desired to make too much profit per car. All were advertised heavily but, because the product was poor either from the price angle or the quality angle or both, advertising could not do the job and therefore became an **expense** instead of an **investment.** California dates, on the other hand, are **most assuredly** an excellent product. At the present time, California dates carry a high price to the housewife, but that can be materially reduced with greater cooperation among the producers with a resultant stronger growers' marketing cooperative and lowered costs. I would not advocate this industry going on a large advertising program unless the cooperation among the producers has been materially strengthened and unless there is good reason to believe that the Indio processing costs can be materially lowered. If this industry is to go along with the same percentage of crop control that United now enjoys and if, though some improvements are made in the present costs of processing at Indio, it would seem that the same advertising budget per pound (½c) that United invested this year, is just about all that this industry can stand under such circumstances.

It so happened that this ½c per pound came to approximately $11 000. While $11,000 isn't very much money for advertising campaigns, nevertheless if judiciously spent and if the sales staff is of a certain type, it can go a long way and too, it can be used almost exclusively to improve the sales prices or volume of those who put up the $11,000. In investing the advertising fund in this manner, that is, to reserve it almost wholly for the benefit of those who furnished the money, we feel that there will **not** be as much profit as would normally accrue if there were a greater percentage of cooperation in the industry as a whole and that the money could be invested in advertising **all** California dates rather than certain specific brands. In order to get the most out of that money under this year's circumstances, it was necessary to confine approximately $8,000 of it for demonstrations in retailers' stores, while the other $3,000 was expended in purchasing printed material to assist in these demonstrations and also to call attention to the fact that these particular stores had these particular brands of California dates for sale. We feel that if United had had a greater percentage of control of the crop and thus, if the sales staff had had less competitive selling, which would result in more constructive selling, that this same $11,000 could have produced a greater revenue if it had been split about $3,000 for demonstrations, $3,000 for printed material, $3,000 for radio participation programs and $2,000 for dissemination of date recipes, uses and publicity stories to the home economics writers of newspapers, magazines, etc. However, if this proposed program had been used this season, it would have produced equally good results for those dates that did not come from members of United and from those growers who did not pay their share of this $11,000.

If the cooperative marketing movement in the California date industry could claim 90% of the production, we feel that an advertising budget of $25,000 to $30,000 per year, in the

proper channels, would bring back to the growers at least 150% of the money invested. Advertising definitely will pay dividends, if used properly and if the product is good and if the organization setup is right and too, it can be made to show **increasing** profits from year to year through its continuity. It was consistently reported by all of our offices this year, that the trade preference was decidedly in favor of the Desert Gold Brand and this, we feel, is directly traceable to their past years of continuous advertising of their brand name and their maintenance of good, average grading standards. The fruit of United as a whole, was benefited by the reputation of this one brand, which has been consistently advertised for quite some years.

In summarizing, I feel that the California date industry has a particularly bright future. Tremendous strides have been made in a very short time in cooperation, and there is undoubtedly a better feeling in the Valley than has existed for some years. It is certainly reasonable to believe that improvements on the part of all will continue to be made, and, as we gather additional experience as we stick together, an increasing number of the public's dollars should be returned to the producers of California dates. United Date Growers of California vitally needs additional members and their tonnage, and, on their records for their first season, they should enjoy additional growers' confidence. Too, it should be remembered that each additional thousand pounds of dates going through United means 1,000 pounds and perhaps 20 customers less on competition, which leaves approximately three or four more hours for constructive selling rather than competitive selling and, **in addition to that**, each thousand pounds would bring another $5 bill into the advertising fund with which to back up that extra three or four hours of constructive selling. If these few remarks will prove of benefit to the California date producers, I shall indeed be happy. There is just one request I would like to make of you, and that is that you will please remember that the estimated figures net to the grower that were mentioned a short time back, were **purely estimates and not promises.**

Leaf Pruning and Fruit Thinning Following the Freeze of January, 1937

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AFTER the freeze of January, 1937, injury to many date leaves was soon apparent. With some varieties, such as Khadrawy, all leaves were severely injured. With Deglet Noor palms in full bearing, only the lower leaves were, in most instances, entirely dead. Above these dead leaves were others with the lower midrib and portions of the lower pinnae showing more or less green color, but with the outer portions of the leaves and the tips of many of the lower pinnae dead. In general there was progressively less damage upward, toward the center of the crown of the palm, with the exception that the bud leaves just unfolding frequently showed more injury than adjacent fully mature leaves.

This reduction in amount of normal, green leaf area due to the freeze raised the question as to the amount of green leaf area necessary for normal growth and fruiting of palms. Since the carbohydrates necessary for leaf growth, flower development and fruit sizing are manufactured in the leaves, it was presumed that a reduction in the green leaf area would result in a limitation of the carbohydrate supply to the palm. Under such a condition it seemed possible that the remaining green area on severely injured leaves might be of value in minimizing such a limitation in carbohydrate production by the leaves. Therefore, growers in general were advised to retain all leaves showing any live green tissue.

Appreciating the immediate and urgent need for more information upon the relation of leaf area to fruit production in the date, the trustees of the Coachella Valley Union High School offered a block of Deglet Noor palms on the school grounds for experimental use. At the suggestion of growers a study was begun to determine whether the retention of leaves severely injured by the January freeze but showing some green pinnae would be of practical value. Since previous work (Nixon, Roy W. Further Experiments in Fruit Thinning of Dates. Date Growers' Inst. Ann. Rept. 13:6-8. 1936) had shown that the amount of fruit borne one year influences the number of spathes produced the following year, the experiments were extended to include a study of the effects of fruit thinning in 1937 upon fruit production in 1938.

Seventy Deglet Noor palms were selected for study. The palms varied in height from about 8 to 14 feet, most of them being about 9 years of age. Even before the freeze the palms as a whole were somewhat lacking in thrift and vigor, due probably to inadequate fertilization and irrigation over a period of years, and this undoubtedly was partly responsible for the low total yields noted later. The damage from the January freeze was about typical of that sustained by palms of the same variety and size throughout Coachella Valley.

The experiment as laid out included 14 rows of 5 palms each. The even numbered rows were pruned on February 25. In this pruning all dead and severely damaged leaves were removed up to the first leaves that had any normal green pinnae in the basal portion of the blade. About 31 leaves per palm were cut and there remained after pruning an average of 22 leaves per palm. A few leaves, not exceeding about 5 or 6 per palm, were said to have been cut prior to the freeze. It should be borne in mind that even the leaves retained had some dead areas at the tips of leaves and pinnae. In fact, every leaf exposed at the time of the freeze was more or less damaged and it is still possible to distinguish them from the new leaves, of which an average of 29 per palm throughout the block were produced during the 1937 growing season. After the pruning on February 25, no further leaves were removed from either pruned or unpruned palms with the exception of those which broke from time to time or those entirely dead which often began to hang down and interfere with cultivation.

Three different fruit thinning treatments were proposed and also a treatment which consisted of cutting

off all bunches. One treatment was planned to conform with the usual commercial practice, leaving as many bunches of moderately thinned dates as the palms might be expected to carry if they were in normal condition, the number of bunches being set at 8 to 12 provided there were enough flower clusters. In another treatment the same number of bunches were to be left, but approximately 50 per cent more of the dates removed by cutting back the tips of the strands in an additional thinning. In the third treatment the bunches were to be moderately thinned but the number reduced to 4 per palm. All bunches on all palms were moderately thinned at time of pollination in accordance with commercial practice, but the supplementary thinning and removal of excess bunches necessary for the differential treatments were done on June 1.

Each fruit thinning treatment was applied to two adjacent rows, one pruned and one unpruned. Since the palms were somewhat smaller and weaker in the west end of the block, increasing a little in size and vigor toward the east in the direction that the rows were numbered, each of the three treatments was repeated in a different part of the block. This afforded six different comparisons of pruning versus non-pruning — two with each of the fruit thinning treatments. All the fruit bunches were removed from two rows — one unpruned at the west end of the block and one pruned at the east end.

The fruit stalks in 1937 seemed weaker than usual and there was considerable breakage during early summer, especially on the heavier bunches. As a consequence the number of bunches on many palms, particularly where the bunches were not heavily thinned, was below the number planned for the experiment. The actual number of bunches that carried fruit to maturity is given in Table 3.

With the acceleration of growth as the weather began to warm up, the severely damaged leaves on the unpruned palms began to die more rapidly than would have been the case with normal leaves. On nearly every palm throughout the block from 1 to 6 leaves were broken by wind during the spring or early summer. The midribs of such leaves had apparently been weakened by low temperatures even though retaining much apparently normal green tissue. By the end of the summer after removing broken leaves and those entirely dead there was not a great deal of obvious difference in the appearance of foliage on the pruned and unpruned treatments.

The data which do not show any very definite trends are not included in the tables. The percentage of flowers followed by dates reaching maturity was somewhat higher on the more thrifty palms, but was not consistently influenced by pruning or thinning. Blacknose and checking were negligible in amount. Maturity did not seem to be affected.

In both the commercial thinning treatments the percentage of A grade fruit was about twice as high for the unpruned palms as for the pruned palms, 9.3% versus 4.8% in one comparison and 5.4% versus 2.7% in the other. This indicates that the retention of severely injured leaves showing some green color was of value in increasing the percentage of A grade fruit. Also the percentage of A grade fruit was higher where the bunch was moderately thinned than where the bunch was heavily thinned. This smaller percentage of A grade fruit following heavy thinning June 1 was probably partly due to the greater exposure in heavier thinned bunches and is in line with results obtained in large-scale thinning experiments previously reported (Nixon, Roy W. Bunch thinning experiments with Deglet Noor dates. Date Growers' Inst. Ann. Rept. 12:17-19. 1935).

Very little shrivelling showed up in the experiment, but the data are presented in Table 1 because they show a fairly consistent difference in favor of the unpruned palms. This difference in favor of the unpruned palms, it will be noted, was greater on the smaller and less thrifty palms in the west end of the block and decreased toward the other end, where the palms were larger and stronger, there being no difference at all in the two rows compared at the east end of the block. This may be taken as evidence that on the weaker palms the retention of severely damaged leaves was of more importance than on the stronger palms.

The outstanding result of the experiment in 1937 was the slight increase in yield which resulted from retaining all the severely damaged leaves on the palms. Because of the variation in number of bunches per palm the effect of the pruning treatment can best be seen in the average number of pounds per bunch. The data given in Table 2 show that the number of pounds per bunch was higher without pruning than with pruning for five of the six comparisons, involving each of the three different fruit thinning treatments. The sixth comparison, where there was no difference in the yield per bunch, included the most vigorous palms. As already suggested in the case of shrivelling, it is possible that with these more vigorous palms the retention of severely damaged leaves was of less importance than for the less thrifty palms.

TABLE 1

Effect of Retaining Severely Injured Leaves Showing Some Green Pinnae in Reducing the Percentage of Shrivelled Fruit.

	West to East					
Plot Number	1	2	3	4	5	6
Unpruned	0.7	0.9	0.7	0.3	0.3	0.5
Pruned . . .	1.5	1.5	1.8	0.6	0.4	0.5

TABLE 2

Effect of Retaining Severely Injured Leaves Showing Some Green Pinnae in Increasing the Yield (pounds) per Bunch.

	West to East					
Plot Number	1	2	3	4	5	6
Unpruned . .	8.1	13.3	4.1	10.4	17.8	5.2
Pruned . . .	7.0	12.2	2.6	9.6	11.3	5.2

As was to be expected, the reduction in number of bunches and the heavier thinning of bunches reduced the total yield in those treatments, but the object of these more drastic reductions in the quantity of fruit carried in 1937 was primarily to determine the effect of the 1937 crop upon that of 1938. At present our only index to the 1938 crop is the number of spathes appearing in the spring of 1938. The average number of spathes per palm showing on April 4, 1938, is given in Table 3 opposite the average yield and number of bunches per palm in 1937. A few more spathes may show up, but it does not seem likely that the relative proportion of total spathes for each treatment is likely to be changed. There is no obvious relationship between leaf pruning in 1937 and the number of spathes appearing in 1938. Comparisons of thinning treatments are for simplicity given separately for pruned and unpruned palms and for east or west halves of the block.

The results show very consistently that the heavier yields in 1937 are being followed by the emergence of fewer spathes in 1938. These results indicate that the number of spathes produced in 1938 was influenced by the amount of fruit produced by a limited leaf area in 1937.

TABLE 3

Effect of Reducing the Amount of Crop in 1937 Upon the Number of Spathes Produced in 1938

	Average number of bunches per palm	Average yield per palm in 1937 (lbs.)	Average No. of spathes per palm June 2, 1938*
Unpruned palms, west			
Commercial fruit thinning	7.4	60	6.4
Heavy fruit thinning on individual bunches	9.8	40	9.0
Commercial thinning on bunches with number of bunches reduced	3.0	40	8.4
All bunches removed	0	0	11.0
Unpruned palms, east			
Commercial fruit thinning	7.6	79	5.8
Heavy fruit thinning on individual bunches	11.8	61	11.2
Commercial thinning on bunches with number of bunches reduced	3.2	57	13.0
Pruned palms, west			
Commercial fruit thinning	7.4	52	5.4
Heavy fruit thinning on individual bunches	11.2	41	8.8
Commercial thinning on bunches with number of bunches reduced	2.2	27	10.8
Pruned palms, east			
Commercial fruit thinning	7.4	71	7.2
Heavy fruit thinning on individual bunches	11.0	57	10.0
Commercial thinning on bunches with number of bunches reduced	3.0	34	11.0
All bunches removed	0	0	14.4

*Note: Counts were made on April 4 as read at the Date Institute, but on June 2 the number was rechecked so as to include subsequent spathes which in some instances resulted in a slight increase over the original figures.

Summary

The results thus far justify the following conclusions:

1. With the leaves on Deglet Noor palms severely injured by the freeze of January, 1937, retaining those injured leaves which had some green pinnae, as compared with cutting off such leaves, gave a slightly greater yield in 5 out of 6 cases.

2. With limited leaf area in 1937, reducing the amount of crop in 1937, either by reducing the number of dates on the bunch or by reducing the number of bunches on the palm, increased the number of spathes produced in the spring of 1938.

DISCUSSION

W. E. Jenkins: Did you do anything to increase the vigor?

Nixon: No, we did nothing.

Question: Were the leaves left on all good before the freeze?

Nixon: They were not inspected before the freeze.

D. H. Mitchell: Did the removal of all the date bunches increase the vigor of the palms?

Nixon: There was not any apparent difference, but no measurements of growth were made except a record of the number of new leaves produced which was fairly uniform throughout the plot, averaging 29 per palm in 1937.

Question: What is the number of leaves generally produced?

Nixon: That would vary according to variety, season, soil and other factors. We have kept records at the Experiment Station and find that under our conditions about 25 leaves per year are produced on mature Deglet Noor palms, and it may be of incidental interest that our records show that five palms on which records are being kept produced more leaves last year than for any of the last five years.

Question: What is the average number of bunches?

Nixon: 8 to 12.

Question: Are the 1938 spathes stronger on the palms from which the fruit was cut in 1937?

Nixon: That has not been determined yet. Apparently the vigor of the spathe depends largely on the size and vigor of the palm.

DISCUSSION OF THE LATER EFFECTS OF THE FREEZE OF JANUARY, 1937

Led by Roy W. Nixon

THE paper I have just read was intended as an introduction to a general discussion of the later effects of the 1937 freeze. When we discussed the immediate effects of the freeze at the Date Institute last year it was generally agreed that the discussion should be continued until the story is complete. Well, it appears now that it will be at least another year before many of the palms are back to normal, but perhaps by this time we can anticipate the climax and record what may be the most important chapter in the story.

Serial stories often begin each installment with a synopsis of preceding chapters. So for the benefit of those who may not have been here last year it might be well to state briefly a few facts already well known to most of you.

Early on the morning of January 22, 1937, Coachella Valley experienced the lowest temperature ever recorded to date at the U. S. Experiment Date Garden. The minimum was 13 degrees F. and the thermometer was at 20 and below for about 5 hours. On two successive nights the minimum temperature was 18. These low temperatures were widespread without much variation. They were slightly higher in the foothills and toward the south and east, but very general over Southern California and the Southwest.

A survey of date palms following the freeze indicated that 20 degrees F. is right around the critical temperature where serious damage occurs. Wherever a minimum temperature of 20 degrees F. or lower was recorded for any length of time there was considerable injury to date palms. In a few instances where the minimum temperature was slightly higher there was practically no damage.

The injury from low temperatures was less on large palms than on small palms and there was considerable variation in the damage occurring among the different varieties. While differences were not always consistent, from a survey of a large number of gardens in Southern California and Southern Arizona the following commercial varieties appeared to have been least damaged: Zahidi, Thoory, Deglet Noor, Dayri, Tazizoot, Hayany, Iteema and Sayer. Among those most damaged were Khadrawy, Maktoom, Khalasa, Halawy, Saidy

and Barhee. Some observers have placed the last two in each list in an intermediate group, but it is difficult to make fine distinctions and with any grouping some varieties would be on the borderline.

I have asked the same growers who reported on the immediate effects of the freeze last year to give us the benefit of their further observations and if there are any others who care to make any comments we will hear from them at this time.

H. L. Cavanagh: At the Date Institute a year ago we were speculating on the effects of the freeze and how far reaching it would be. I am still speculating. In the cases I mentioned a year ago, I have made these observations: The young palms, that at the time appeared to have lost about 90% of their tops, actually lost close to 100% of their leaves. These palms did not mature a crop of dates, although some of them were allowed to carry several small bunches. The fruit stems were very small and short and the dates were too small to be marketable, even in the No. 2 dry pool. These palms have made a new top of about 35 leaves and are this season showing a good set of normal appearing spathes. The palms mentioned a year ago as being 7 years old and showing about 60% damage, matured a crop amounting to 66% of the previous year's crop on the same palms. Palms in this group that were allowed to carry more fruit than they should have had, are those showing the greatest percentage of non-blooming. There were many more broken fruit stems on these palms than is normally expected—probably due to a weakened fruit stem condition and to a lack of supporting fronds. Palms 20 years old with trunks ranging to 35 feet to the first leaves bore a normal crop of good-grade dates and are this spring blooming normally. We have this spring blocks of palms running as high as 44% non-blooming. These are full-bearing palms that, it appears now, were allowed to over-bear last year. This over-bearing could have been prevented, I believe, through a knowledge of the proper leaf-area fruit ratio.

L. Swingle: The only comment I have to add to last year's report is that the injury has proven to be much worse than appeared then. There does not seem to be the difference in frost resistance between varieties that appeared a year ago but more difference in frost injury correlated with the size of the palm. In all cases the smaller palms were injured worst and the largest palms least, but the smallest palms have made the quicker recovery. Palms most exposed, as on the north and west sides of a garden were injured more than those protected by being in the center of the garden or otherwise.

Palms which were very badly frozen and lost about all their leaves and on which the fruit was all cut off a year ago, have usually recovered enough to grow a new crown of leaves have a respectable bloom this spring, whereas palms which appeared much less injured and were allowed to carry a crop last fall, not only failed to properly mature that crop but have little or no bloom this spring. For this reason frost injury to varieties and individual palms must be considered over a two year period rather than the first season. That is, we hope that two years will be sufficient to bring the palms all back to normal but we will know better next spring.

One observation that I have not seen made and that might be well to put in the record is that the breather roots at the surface of the ground around the trunk of the palm and the spike roots being put out above the surface of the ground were all badly injured by the freeze. We find the roots in the mound at the base all dead for several inches but below that they appear normal. There was much less development of aereal and breather roots last season than normal, due no doubt to the severe injury of all these exposed roots by the freeze. What effect this will have on the palm, is of course not known.

W. E. Jenkins: What I have noticed on my own palms bears out the experiment at the high school as described by Mr. Nixon.

T. J. Gridley: I have not come to any definite conclusions. Generally palms from which fruit was entirely removed last year are blooming vigorously this year. The older palms which were allowed to bear last year have been more delayed in flowering this year; the spathes are weaker and many of the palms have failed to bloom at all. Many of the leaves are still damaged. It will be at least one year and probably two years before the leaves get back to normal and the palms produce a normal crop of fruit.

Pieratt: Of the larger trees, about ten years old, we took five and cut off all the fruit; on five we left one-third of the crop; on five, two-thirds of the crop; and on five, a full crop. Where a full crop was left the fruit was of very poor quality. With the two-thirds crop it was a little better and on the others still better. The five trees that had all fruit cut off are blooming lots earlier this year, the bunches seem lots stronger, and the tops of the trees look better. The five trees that had the full crop have not put out many blossoms so far this year, but we can't tell yet just what they are going to do.

R. H. Gray (Calexico): I do not feel that I have very much to offer. We started a sugar beet experiment between our palms. The beets are dependent on the sugar beet factories for harvesting and the few dates we did have were small, but I cannot tell how much of this small size was caused from the freeze and how much from the beets. Thoorys have put out lots of blossoms this spring. They appeared badly frozen last year, but now have more blossoms than the Zahidis or Halawys have. There is a large difference in the way the different varieties are coming out this year.

C. A. Whipple (Bard): It was very evident that the Dayri dates were less affected than any other variety that I have. This variety has come out with more blooms this year than any other. I cut all blooms on all palms — Halawy, Khadrawy, Zahidi and Dayri, to promote palm growth. The palms have made excellent progress in the past year. At present there is practically no evidence of the freeze. This year very few palms have bloomed and these have not put out as many blooms as had been anticipated. These palms range from 3¾ to 4¾ years old.

H. H. Taylor (Phoenix): The Phoenix Date Co. had slight damage. Damage was much greater at the Tropical Groves, a supposedly warmer area. Spathes seem to be coming out fairly well so far.

Nixon: In concluding this discussion let us see if we can summarize our observations thus far.

1. The freeze of January, 1937, had no effect on the 1937 flowering of dates.

2. Partially injured leaves have died more rapidly and have broken more easily than normal leaves would have done.

3. In some instances where palms were seriously damaged the fruit stalks seemed weaker; at least where leaves around the fruit stalks were entirely dead there was more breakage than usual, although greater exposure and less support might have been responsible for some of this.

4. On seriously damaged palms the size of the fruit was apparently somewhat smaller. This was noticed in a number of cases where the leaves that subtended the 1937 fruit stalks were dead.

W. E. Jenkins: The whole date crop was $\frac{1}{8}$ inch smaller in 1937.

5. Quality appears to have been affected in some cases on palms severely damaged. A number of growers have told me that their grades were lower and in the case of some soft varieties like Khadrawy that the fruit was lacking in sugar content, being soft and mushy. On the other hand with the Halawy variety, which was injured about as much as any, the dates at the U. S. Experiment Date Garden were better than any we have had for several years.

W. W. Cook: Last year in the California Date Growers Association some of the dates were the most beautiful we have ever seen. We also had some of the rottenest for general quality. There was a low percentage of high grade fruit, but such as there was, was beautiful fruit. The average grade-out of Deglet Noors in the California Date Growers Association for the last three years is as follows:

	1935-36	1936-37	1037-38
A	10.1%	3.9%	3.2%
B	50.5	33.9	30.0
D	25.3	32.7	28.3
D	10.5	Dry 10.9	Dry 27.2
		Soft 14.6	Soft 8.2
Culls	3.6	4.0	3.1

Total pounds Deglet Noor:
2,260,613 2,557,274 1,991,316

6. Could we say that the palms were slower in flowering in 1938 because of the freeze of January, 1937?

W. W. Cook: I take exception to that. The most severely damaged palms we have are the ones that bloomed the earliest.

R. Russel: Our palms are not any later this year than they have been in some years past.

Nixon: It is true that the season has been very erratic. On varieties or palms slightly damaged flowering this spring has been about normal. This is true of Zahidi, Hayany, Tazizoot and Thoory at the U. S. Experiment Date Garden and it is apparently the case with some of the older and larger Deglet Noor palms thruout Coachella Valley. Even palms severely damaged appear in some instances, where all the fruit was cut off last year, to be flowering about as usual. On the other hand, the past winter has been unusually mild and we would ordinarily expect early flowering, yet at the U. S. Experiment Date Garden and in a good many other gardens where observations have been made, palms that were allowed to bear much of a crop in 1937 in spite of considerable damage from the freeze have been much later than usual in flowering this spring. May not the 1937 crop in relation to the injury from the freeze account for this delay in flowering in 1938?

7. Palms that were severely injured by low temperatures in January, 1937, and were allowed to bear any considerable quantity of fruit in 1937 have almost without exception borne a very light crop of flowers in 1938, the number of flower clusters being more or less in inverse proportion to the 1937 crop. As an extreme example the following observations were made in one of the larger plantings of Khadrawy where mature palms over 20 years of age were estimated to have been about 90 per cent defoliated. In this garden in 1937, 40 palms in two rows bore an average of 13.7 mature bunches of fruit with all palms fruiting, whereas in the spring of 1938, 14 of these palms have failed to put out spathes and the other 26 have an average of only 3.6 flower clusters per palm.